The SCIENCE COUNSELOR

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

VOLUME III
NUMBER 2
JUNE, 1937

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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

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Volume III JUNE, 1937 No. 2

CONTENTS

IT IS TIME TO ACT 33

A SCIENTIST'S PRAYER 34
Sister Mary Gertrude

VISUAL AIDS IN SCIENCE EDUCATION 35
John A. Hollinger

A NEW LABORATORY METHOD OF TEACHING PHYSICS 37
H. Clyde Krenerick

GEOLOGY AND ITS RELATION TO THE OTHER SCIENCES 40
Timothy C. May

INSTITUTUM DIVI THOMAE 42
Reverend Cletus A. Miller

SEED GERMINATION 43
Sister Mary Ellen

MANUALS AND WORKBOOKS IN THE PHYSICAL SCIENCES 47
W. H. Kadesch

AIR CONDITIONING THE HOME 49
Catherine Mary Melanson

THE STORY OF AN OLD BOOK COVER 50
Sister Mary F. Xavier
Edward Kremers

THE COST OF EQUIPPING A LABORATORY FOR SEMI-MICRO CHEMISTRY 52
Sister M. Lawrence
William J. Schiller

YOU SHOULD READ 53

COMING IN FUTURE NUMBERS 56

It Is Time To Act . .

Are you *really* interested in THE SCIENCE COUNSELOR? Do you want it to continue? Would you like to see it develop and grow? If so, you must act.

THE SCIENCE COUNSELOR is a worthy addition to the literature of science. Teachers in the field say that it is helpful. Although its efforts are directed toward aiding, advising, and counseling teachers of science in the Catholic high schools, many others including instructors and supervisors in the public high schools, and in colleges and universities as well, have expressed their appreciation of the inspiration and help it has given them. Teacher training institutions and summer schools for teachers, Catholic and non-Catholic, use it for instructional purposes. Outstanding educators, scientists, and administrators of all religious beliefs contribute freely to its columns. Subscriptions have come from libraries, great universities, and teachers and executives in public schools as well as from others not in the high school field. Advertisers find our space a valuable medium for the sale of their goods.

All these, then, believe that this journal has merit, that it has a place. If it has merit, it should be supported financially by those whom it benefits. If it has none, it should not continue. The Editor is reluctant to admit that the teachers of science in the Catholic schools are not yet supporting this journal as they should, and as they must if it is to live. The financial burden which Duquesne University assumes in publishing THE SCIENCE COUNSELOR is a very considerable one. It should not and cannot be carried indefinitely by the University without assistance. There is no desire to profit, only to help. This is a non-profit publication—but expenses must be met.

Catholic projects should be supported first of all by Catholics. Catholic Action should be more than a mere phrase. So far as THE SCIENCE COUNSELOR is concerned, you can translate the phrase into action easily and quickly by sending in one or more new subscriptions or by renewing your old subscription at once. Perhaps you have been only waiting to be asked.

Will you act TODAY?

A Scientist's Prayer

● By Sister Mary Gertrude, O.P.

Sister Mary Gertrude Quinn, O.P., B.A. (University of Wisconsin), M.A. (Columbia University), who writes this charming Jubilee poem, is an instructor in science at the Trinity High School, River Forest, Illinois.

The Recently Restored Historic Church of St. Peter, Brownsville, Pennsylvania, Reverend M. J. Brennan, Pastor

Above his glowing crucible the chemist works
To find that in the dull black mass a secret lurks;
And lo! a color loveliness it yields at last
As if a sin-freed soul from out its depths were cast.

And so the Master Chemist, who with power divine
Discerns the latent beauty of the aniline,
Looks deep into the seething crucible of strife
And finds the chastened gold within each human life.

Take then from us, dear God, this complex thing of years,
A compound of our joys and sorrows, hopes and fears,
Concealed beneath its ugliness there still may be
Some worthy thing which we may dare to offer Thee.

Amen.

Visual Aids In Science Education

● **By John A. Hollinger, Ph.D.,** *(University of Pittsburgh)*
DIRECTOR OF VISUAL EDUCATION AND SCIENCE, PITTSBURGH PUBLIC SCHOOLS

This is a very helpful article. The man who writes it is a practical administrator who knows what he is talking about. It should be read with care.

Visual aids help the student "to see clearly, to record accurately, and to infer justly," but many teachers who have available a plentiful supply of good visual aids do not know how to use them properly. Other teachers do not know where to procure them. They can learn from Dr. Hollinger.

This paper is an outline of the illustrated address which Dr. Hollinger recently gave before the fifth annual Duquesne University Conference for teachers of science in the Catholic high schools.

●

Visual aids comprise mainly pictorial representation, graphic presentation and museum materials; also, laboratory equipment and supplies. This discussion is concerned only with the former, not with laboratory equipment.

The general purposes of science courses in education have received rather universal acceptance. In this connection emphasis may be placed upon interest in science; the right attitude toward and skill in reflective thinking based upon objective factual information; and understanding of laws, principles and theories.

Textbooks for use in science education are steadily improving. Magazines, bulletins and circulars of many kinds are rich in scientific materials. On the levels of elementary and of secondary education, visual materials are effective aids. Numerous studies such as those by Wood and Freeman, Weber, Rulon, Hollinger and many others, have supplied a wealth of evidence of the effectiveness of visual aids.

In science education, as elsewhere in scientific procedure, pupils must observe clearly and record accurately what they see. By observing a specimen, facts are obtained at first hand. Skill in observing and recording should be cultivated. Pupils should learn to read from specimens, graphic presentations and pictorial representation. Much effort is expended in learning to read the printed page. Shall other aids be effective learning devices? Then learners must be taught *how to use* them effectively.

Had the camera been invented before the printing press, had Edison lived before Gutenberg, perhaps the record of civilization would be quite different from what it is today. Perhaps specimens, graphs, pictures and similar materials would take precedence over printed matter, especially on the lower levels of education. Perhaps visual materials would be used more on the higher levels than they now are. Possibly much time and energy could be conserved in courses in science. Who will deny the stimulation of interest and the challenge to attention by the use of visual aids?

The printed page is rather drab, often verbose and redundant, with connotations sometimes doubtful. The specimen is real; the chart, poster, cartoon or graph concise and direct; the picture is usually artistic, meaningful and impressive. Subject matter in print is secondary while visual aids furnish more nearly first-hand or primary information. In science teaching judgment based on fact, openmindedness and tolerance, and comprehension of cause and effect relationships are desirable.

Parenthetically, there is no ground for assuming that learning could proceed entirely through the use of visual aids. There must be development of language. A vocabulary is essential to reflective thinking and to active expression. William James said, "There is no impression without corresponding expression."

Extensive literature in this field is available. For a mere sampling, the following are submitted:

1. *The National Elementary Principal*, Thirteenth Yearbook of the Department of Elementary School Principals of the National Education Association, "Aids to Teaching in the Elementary School," June 1934, Vol. XIII, No. 5.
2. *New York State Association of Elementary Principals*, "Visual Aids in the Schools," Bulletin IV, December 1935.
3. Homer J. Smith, "Teaching Aids For The Asking," The University of Minnesota Press, Minneapolis, Minnesota.
4. *Educational Screen*, 64 East Lake Street, Chicago, Ill.

Briefly considered, some effective types of visual aids in science teaching comprise:

I. FIELD AND MUSEUM MATERIALS.

A. **Specimens** properly mounted and labeled.

1. These may be exhibited permanently in the museum and pupils may be directed to visit the museum for specific purposes such as the study of:
   a. The development of transportation.
   b. Habitats of various plants and animals and ecological relationships.
   c. Taxonomy, structure and the implied functions of parts of animals or of plants of the same family; and characteristics, similarities and differences. Classes from the schools visiting the museum are guided by docents in the study of specimens and exhibits. The museum is a veritable storehouse of interesting and valuable information.
2. Specimens displayed in cases for convenient handling are now readily available for use in schools.

B. **At Carnegie Museum,** Pittsburgh, on Saturday mornings a class of junior high school pupils especially gifted in natural science is conducted by members of the Museum Staff.

II. GRAPHIC MATERIALS.

A. **Charts** cataloged by such concerns as Denoyer-Geppert Co., Ward's Natural Science Establishment, A. J. Nystrom Co., Central Scientific Co., Chicago Apparatus Co., General Biological Supply House and many others, comprise helpful classroom equipment. A chart of fifteen major steps in the chain of electric service is another excellent example—Duquesne Light Co.

B. **Graphs** are especially useful in recording facts observed, and in interpreting such facts. Line graphs, column graphs, the pie graph, curves and similar graphic presentations should be used by all students of science. Reports of all types are replete with graphs. Ability to read such reports presupposes a familiarity with methods of graphic presentation.

C. **Posters, cartoons, maps** and similar forms of graphic presentation need scarcely be mentioned to recall their effectiveness.

III. **PICTORIAL MATERIALS** comprise lantern slides, motion pictures, half tones and line drawings in books, magazines, bulletins and other publications; photogravures and similar photographic prints.

A. **A new textbook** entitled *Science* by Davis and Sharpe, published by Henry Holt and Company, contains this statement in the preface—

> "Pictorial diagrams and pictures help the pupil to visualize the most important events in scientific progress and discovery, and to demonstrate the gradual changes which have occurred in the improvement of inventions, apparatus, and machines. An unusually large number of pictures and simple diagrams is used throughout the book to assist the pupil in studying the printed page and to supplement the directions for performing the experiments and demonstrations."

In this new book there are 491 pages with 546 "diagrams and pictures that teach, not mere space fillers." Many good teachers and pupils have learned the value of such illustrations, but many have not yet discovered their effectiveness.

B. **Lantern slides** when projected on the screen stimulate interest and challenge attention. Granted that the science classroom is a proper place for the exchange of ideas, and for understanding laws, principles and theories, lantern slides remain on the screen long enough and can be seen by all concerned to accomplish this purpose.

Lantern slides serve other purposes than merely furnishing illustrative material for lectures. Pupils should be taught how to *read* such pictorial presentation and to interpret the facts presented.

All projection equipment should be carefully maintained so that pictures are properly projected. The novice in the classroom should be free to ask for demonstrations by a skilled projectionist.

C. **A discussion of motion pictures** in science courses might easily have occupied the entire time set for this part of the program. To avoid a lengthy discussion, and for the purpose of more effective presentation, a motion picture will be presented as a type of what is being done in good science classes. Pictures are not substitutes for good teachers. Skillful teachers use pictures as devices to aid in learning. Conscious procedures must be developed by teachers and pupils. In using such a motion picture as "Simple Machines," a type of procedure found to be very effective is somewhat as follows:

1. The motion picture "Simple Machines" may be used as basic material in a major presentation of the subject. A teacher's guide accompanies the picture. In preparation for the use of a motion picture, the lesson plan should be carefully set up. The picture should be completely familiar to the teacher before an attempt is made to present it in class.
2. The next step is an introduction to the subject of "Machines enable man to magnify the force he is able to exert and thus to work more advantageously."
   a. Basic machines are: lever, wheel and axle, pulley, inclined plane, wedge and screw. Such an introduction as is suggested here may be brief or rather extensive depending upon the subject. It may be a brief lecture by the teacher, or question and answer procedure, or free discussion by pupils. In this particular case pupils may be directed to read Pupin's *Romance of the Machine.* Any type of procedure should be used that gives the proper mental set before a motion picture is projected.
3. The third step may be a pretest, quiz—oral or written, formal or informal.
   a. To create a desire for knowledge of facts and understanding of principles.
   b. To focus attention upon important items in the picture.
4. Immediately following the pretest or quiz the picture should be projected. (A minimum of fifteen minutes is required for this). Pupils should be encouraged to ask questions while the picture is exhibited. The projector may be stopped for discussion or to answer questions. The newer types of projectors have a reversible feature so that a particular part of the picture may be repeated for clarification. During the discussion while the film is still, the light should be turned off. Good motion pictures portray motion and do not require still pictures on the screen while the ideas are being presented. (In presenting such a motion picture as "Simple Machines," good practice seems the avoidance of oral comment while the picture is running through the projector.)
5. Immediately after the picture has been presented an objective test should follow. After this test has been scored, discussion is in order to clarify portions of the subject that need such clarification.
6. Pupils then reorganize their thinking in review, state the principles, fix facts and

Continued on Page Fifty-seven

A New Laboratory Method Of Teaching Physics

● **By H. Clyde Krenerick**
NORTH DIVISION HIGH SCHOOL, MILWAUKEE, WIS.

Here is a teacher to whom traditional methods of instruction are not inviolable. He thinks for himself.

Believing that each day's laboratory work in physics should be an individual "problem in research", Prof. Krenerick actually makes it one. To overcome one of the chief obstacles—expense—he has built a number of pieces of "simplified apparatus." Some of it can be made at home. All of it can be purchased if funds are available.

Here Prof. Krenerick describes some of the pieces he has designed and gives hints for their use.

●

It is an almost universal practice to have the laboratory work in physics supplement the classroom demonstration and discussion. At North Division High School the order is reversed. Practically all the elementary laws and principles of physics are first introduced by ninety-five experiments performed by the students working individually in the laboratory.

Each day's task is, to the student, a "problem in research." They are assigned the correlated subject matter in a text. The next day they come to the laboratory and demonstrate for themselves the truth of the principle, or its application to some problem. Their interest has not been dulled by any previous classroom demonstration or discussion.

We believe in rugged individualism. The teacher is not to get the student's lesson for him. Make the task simple and definite, but make the student responsible. It does not matter how simple the task is (and most of our experiments or physics problems can be made simple), if the student accomplishes the task by his own unaided effort, he acquires a mental training and an ability not possible of attainment in group discussions.

To assure previous preparation and to prevent the student from mechanically carrying out the instructions, the manual is written so that, with the text not allowed in the laboratory and with no communicating, the student must be familiar with certain correlated subject matter of the text. Each day's accomplishment is graded; so a failure here is like a failure in a test. This little feature of compulsory preparation is an effective factor in the success of the method.

The single laboratory period of 45 or 50 minutes has some advantages. With no definite day of the week required for laboratory work there can be perfect correlation with the classroom discussion. With single periods the students soon learn that there is not time to follow the instructions mechanically; that they must make preparation, and that they must know what they are going to do and how they are going to do it when they come to the laboratory.

To make such a course most successful, with its short periods and with the students dependent upon their own individual efforts and comprehension, two conditions are necessary. The apparatus must be simple in design and operation. Simple apparatus has its advantage not only in its lower cost but in its greater teaching possibilities. If the apparatus is complicated and involved, students are likely to lose sight of the real purpose of the experiment they are performing.

For the greatest success it is also necessary that the students work individually on a large majority of the experiments. When students work in groups constantly, it usually develops that one or two take pride in preparing for the work and in being leaders. The others are perfectly willing to be led. They do not need to expend any energy in previous study. This does not develop ability for scientific thinking, but it does develop wrong "attitudes and ideals."

To equip a laboratory for the performance of 95 experiments, the large majority of which are in duplicate sets of twenty-eight each so that the entire class may work individually and on the same experiment, the author has designed several pieces of "simplified apparatus" which can be home-made, or can be purchased at comparatively low cost. Some of the designs are for the standard experiments; others are for experiments new in laboratory work.

The following are brief descriptions of several of these pieces. For the complete list of pieces (39 illustrations) and for more complete details of the construction of the apparatus, write to the Chicago Apparatus Co., Chicago, for the copies of their Milvay Note Book describing this "simplified apparatus." Instructions for the use of the apparatus is briefly suggested in these articles. The numbers given refer to the accompanying illustrations.

No. 1. INCLINED PLANE BOARD

This is a board 1″x5″x18″ with a short rod or spike driven into the edge near one end. It can be clamped to a vertical rod giving an incline of any desired grade. For the experiment on the inclined plane, it has an advantage over the usual form using pulley and pan. The students are likely to confuse the weight in the pan with the weight that is being lifted against gravity.

With a friction block, 2″x4″x5″, the board may be used to determine the coefficient of friction in two ways. With the board horizontal, the force of friction and the total normal pressure, or weight, may be measured directly. After the study of the parallelogram of forces, the coefficient of friction may be determined by resolv-

ing the force of gravity into the force of friction and the normal pressure when the board is inclined at the angle of repose.

Another interesting experiment is to find the efficiency of the inclined plane at different grades, showing that it increases as the friction decreases. The work done against friction is obtained by finding the difference between the output and the input. This is then checked by direct measurement—force of friction on the horizontal times the base. The top of the friction block has a hole of the proper size to receive the hook of the four pound mass. This prevents the mass from sliding off the block when on the plane.

No. 2. WHEEL AND AXLE

The drum or axle is made of wood about one and a half inches thick and nine inches in diameter. The handle arm is about six inches. A flat-bottomed groove is cut in the rim of the drum. When set up and at rest the theoretical mechanical advantage may be shown equal to the ratio of the radii. If the balance is held in the hand and read as the weight is being lifted, the actual efficiency can be determined by computing the input and output for one rotation of the wheel and axle.

No. 3. PRONY BRAKE

Here the wheel and axle apparatus is used as a prony brake for measuring the horsepower of the student. The hole in the drum fits a short 19 mm. support rod. The student is instructed to move the clamps along the edge of the table until the friction is about all he can rotate against for one minute. He then must count his own revolutions per minute. This makes it possible to have an experiment demonstrating the measurement of power when the subject is being studied, rather than months later after having the electric motor.

No. 4. ACCELERATED MOTION BOARD

The board may be any size. A standard drawing board painted black is shown in the illustration. With clamp and blocks it may be secured to the table at any angle. By a trial or two it can be determined how fast to roll the ball along the groove so that it will roll off the board near the opposite corner.

If a thin dusting of lycopodium powder is placed on the board and then blown off after the ball has rolled over it, a sharp line showing the path of the ball will remain. The horizontal velocity on the board may be considered constant. Equal horizontal spaces will represent equal time intervals. The distance the ball rolls down the board during each of these spaces or intervals of time is then easily measured. This will give almost perfect results, and all of the laws of accelerated motion can be demonstrated.

No. 5. BOYLE'S LAW TUBE

It is made from a 36" heavy-wall tube of 4 mm. bore. The closed end is 9" long and bent to an angle of 60°. The mercury can easily be placed in the tube. It is not taken out of the tube or handled by the student; so it does not get dirty. By means of a universal clamp it can be supported at any angle thus varying the pressure on the confined air. The pressure is measured by determining the differences in level of the mercury surfaces.

No. 6. PHOTOMETER BOX

The box is 6"x6½"x41". The opening in the front is sufficiently long for the variations of the position of the photometer. Two holes of proper size to receive an electric light receptacle are placed in the top. Bulbs are then placed in the receptacles from the inside. Several of these photometers may be used in the same darkened room without interfering results. By placing a black cloth on the box and over the head, the photometer may be adjusted in partial daylight.

No. 7. OPTICAL BENCH WITH HOLDERS AND OBJECT

The bench is a 100 cm., with 19 mm. support rod. One end support contains a ¾" hole. The second support has a $\frac{3}{16}$" hole to receive the threaded end of the rod. Right-angle clamps are used to support the various objects on the bench. The holders for the lenses, mirrors and screen are made from blocks of wood and mounted on spikes or rods. The 4" lens holder may hold the 4"x4" plane mirror, or it may hold a cardboard and thus serve as a screen. Lenses and mirrors are never broken by falling from these holders.

The object box is about 3½" in each dimension, and mounted so that it can be supported on the bench. One side contains a hole to receive an electric light receptacle so that a light (15 watt) may be placed inside the box. The opposite side contains grooves in the top and bottom so that a lantern slide may be placed therein and become the object to be focused.

When focusing on printing, more accurate adjustments are made. Another advantage over the flame as an object is that it does not light the room and interfere with the results of others. This box makes possible an interesting study of colors. Colored glasses are placed in the grooves, and different colored objects are observed in these different colored lights.

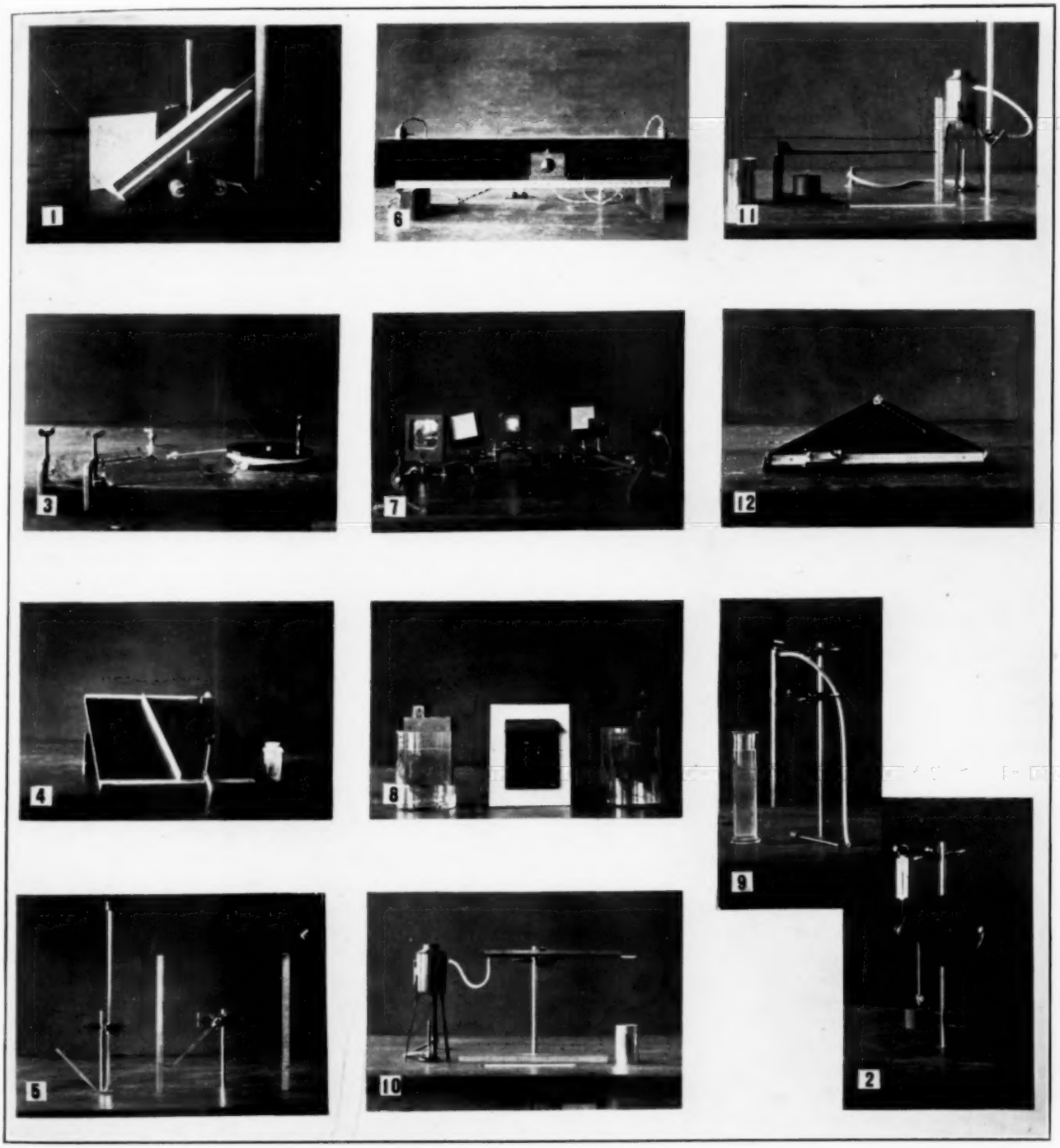
No. 8. INDEX OF REFRACTION BOARD

This is a board ¾"x5½"x7½" with a small groove sawed across one side near the center. Two nails extend through the board at points below the groove or water level. A third nail is placed on the top of the board apparently in line with the two in the water. When the board is removed from the water, dried and placed on the note book, the main points and lines can be transferred to the page and a drawing easily constructed for the determination of the index.

No. 9. A RESONATING TUBE

It is a brass tube 18" long and 1" in diameter. Very near one end is a short right-angle tube. When the end of the rubber tube attached to the right-angle tube is held to the ear, the reinforcement is very sharp

Continued on Page Sixty-one



SIMPLIFIED APPARATUS FOR THE PHYSICS LABORATORY

Devised by H. Clyde Krenerick of the North Division High School, Milwaukee, Wisconsin. The accompanying article describes these laboratory set-ups and tells where they may be obtained and how they can be used.

Geology And Its Relation To The Other Sciences

● By Timothy C. May
DEPARTMENT OF GEOLOGY, THE CATHOLIC UNIVERSITY OF AMERICA

One of the first steps up the sociological ladder is the understanding of one's environment. Yet many modern people, otherwise well educated, lack a knowledge of geology, the most general of the natural sciences. Just now in academic circles, for some obscure reason, this "method of approach to the fundamental laws of Nature" is apparently being neglected. It should not be.

Here Mr. May very capably discusses geology in its relationship to the other sciences, and shows its importance in the general plan of education.

This article should give you some new ideas. It will stimulate your curiosity. It may awaken in you an increased interest in our "laboratory of geology."

●

Where in the family of sciences does Geology belong?

It is considered by some to belong in the physical science division, but its position is an anomalous one. In the writing of the histories of science, geology is scarcely mentioned, or if mentioned at all, it is named only in discussing some special theory.

By its use of the facts, techniques, and laws from other sciences, geology is related to each of the fundamental sciences. It might be placed in a central position with others around it. Man has always been interested in the earth. It is his to possess and enjoy.

The earth might conveniently be compared to a vast laboratory in which chemical, physical, and biological experiments are being enacted continually on a grand scale. Temperatures and pressures are here attainable that greatly transcend those possible in experimental science. All the elements that the chemists have thus far discovered, and possibly others that they have yet to discover, are to be found in the earth. These elements are combined in a vast number of chemical compounds that are continually undergoing change. In spite of this, the changes which the earth can undergo are entirely in accord with the laws of our experimental sciences, for these sciences have been evolved through the study of terrestrial phenomena. Thus, we see that in order to understand adequately the wonders of geology, we must first have a speaking acquaintance with the most fundamental applied sciences, especially chemistry and physics.

Natural science, for all practical purposes, resolves itself into a study of the material substance and the energy transformation of the globe upon which we live. By our study of these we may deduce laws of more universal applicability, such as the application of mathematics to astronomy, but our fundamental concepts are always basically terrestrial, for the earth defines the limits of our perceptual contact. The physicist concentrates on the energy factor, the chemist on the material substance; but each must borrow the laws of the other, because energy and matter are indissolubly related. The biologist studies the organic life of the earth, the physical substance of which comes entirely from inorganic terrestrial sources. All these sciences are the man-made pedestals upon which rests the science of geology, which is the study of the earth itself where chemistry, physics, and biology are carried on, on a grand scale. It thus becomes evident why geology, the most general of the natural sciences is often left to the last, and too often entirely ignored. Just as a baby must crawl before it can walk, so we must learn to handle centimeters and test tubes before we can work with miles and cubic miles.

The laboratory of geology is a very large one; it comprises our entire globe. The earth, though insignificant in the universe, is tremendous when compared to puny, man-made creations. With a diameter at the equator slightly less than 8,000 miles, and a circumference of nearly 25,000 miles, it possesses a weight of 6,000 million million million tons. This is rather a sizable mass for a mere "mote" in the universe! The nearest star, the sun, has a diameter of about 100 times that of the earth, and is 93 million miles away. Others, more remote, cannot conveniently be estimated in such a small earthly unit as a mile, but must be stated in light years. (A light year is the distance that light can travel in a year at the terrific speed of 186,000 miles per second.) It is not uncommon to have stars as much as 500 light-years from the earth. If such a star were rendered non-luminous tomorrow, we would not be able to ascertain this fact until the year 2437!

Although the average density of the earth is 5.5, all its crust that we can get near enough to analyze averages only about half of this—about the density of a piece of ordinary granite. Since water weighs 62.5 pounds per cubic foot, distributed over 144 square inches of base, and rock is about 2.75 times as heavy as this, it is easy to calculate that for every foot of depth of such rock there is a static load of approximately 1.2 pounds. A mile down, therefore, a minimum pressure of 5,280 times must exist, or about 3 tons per square inch.

Is it a wonder, then, that chemical reactions take place down in the earth that are difficult to reproduce in the chemical laboratory where we use centimeters instead of miles; grams instead of tons; and temperatures of ten degrees instead of thousands? Under natural geological conditions a piece of granite may suffer flowage and be kneaded like a piece of dough, giving rise to metamorphic equivalents such as schists

and gneisses, that characterize the oldest rocks that share the earth's surface.

Geology grades into physics in dynamical and engineering geology; into chemistry in mineralogy and petrology; into biology in paleontology; into geography through physical and structural geology. Geography and geology, however, have somewhat different points of view which lie primarily along the dimension of time. Geography points out the existing characteristics of the sphere upon which we live and irrevocably pass our existence. It is logical, therefore, that we should seek the best from our earthly abode that is possible, and, by a thorough knowledge of the geological structures that we have inherited from it, utilize them in their fullest measure during our life; and dying, bequeath a richer legacy of the knowledge of their blessings to those that are to come.

Geology plunges still deeper into this fountain of knowledge. Turning back the hands of time through countless ages, it reconstructs the genealogy of the structure of which the geographer now speaks, going back to the time when the crust as we now know it was quite different. In a word, geology is related to geography in the same way that anthropology and archaeology are to sociology and history.

Let us take a simple example. Everyone knows the relative location of the Rocky and Appalachian mountains. There are few, if any, who do not know that the Rockies are higher than the Appalachians. The drainage patterns are quite different. The drainage streams of the former are dendritic, as we would normally expect them to be, with the tributaries entering the main stream at an angle, like the limbs of a tree. The water goes "down and around" like the music in a now infamous song-hit. In the Appalachians the stream pattern is trellissed; by that we mean the major tributaries parallel for a considerable distance a certain "grain" and often meet the main stream almost at right angles; and the main streams go through the mountains, not around them. These breaches through which pass the major streams, such as the Delaware, Susquehanna, Potomac and James Rivers, are called water-gaps, and can signify but one thing, that the stream course was there before the present mountains.

Let us look over those remarkable mountains. Instead of being made of granite cores, the Appalachians are constructed of sedimentaries containing sea-shells. Logic leaves us but one surmise; there must once have been an ocean, or an arm of one, on the site of our present mountain. Let us move to the crest and look out with a more calculating gaze upon the panorama spread before us. We now notice a series of parallel unbroken ridges of remarkably similar height such that, if we fill in the intervening valleys, we will reconstruct an elevated plane, or peneplane, from which these mountains were etched out. The weaker tributary streams etched away the softer, more soluble strata, and formed the limestone valleys, such as the valley of the Shenandoah, while the more durable quartzitic ridges stand out in bas-relief.

There is a certain group of male propagandists that hint that curosity is a characteristic possessed mainly by women; this is not entirely true. As a matter of fact, curosity is the veritable essence of scientific achievement. It is difficult to imagine how any woman could be more inquisitive than a geologist, unless possibly the latter were a woman! Having found out that a sea-way preceded the Appalachian Mountains, geologists next wanted to know when that was. As one might expect, finding out was a long and laborious task. As a result of the work of many experts, it was found that certain fossils always occurred stratigraphically lower—were buried earlier—than others. Certain of these enjoyed world-wide range during their time of occurrence but were restricted with respect to geological time; we call them index fossils. Once established, these make fine labels for the rocks in which they occur. By means of them, geologic time is divided into various serial divisions. The Appalachians were originally buckled up millions of years ago before the Rockies were geologically dreamed of; and by the time the Rockies started to fold up, stream erosion had reduced the Appalachians to flatness. And, in this cretaceous peneplane, the ancestor of what was to be the Potomac meandered slowly to the sea which covered the present site of Washington, D. C., depositing sands. Still later, the eastern coast of North America suffered considerable uplift; the sea which covered Washington was withdrawn to the distant limits of the eastern shore of Maryland. The Potomac was thereby quickened. In some places it incised its meanders; in others it cut water-gaps through ridges that were being etched out by tributaries scouring deeply into the soft and up-tilted limestone layers, forming conditions such as one may see at Harper's Ferry, West Virginia.

Geology contacts biology in paleontology—the study of fossils. These organic remnants of past geologic ages have left their imprint on everything they touched. They were the stepping stones of our present fauna and flora. They are more than the biological freaks that the uninitiated think them to be, for they find practical employment as time-markers of the earth's history. By their presence they tell us the age of the individual strata of which the crust is composed. The organic nature of fossils had been recognized as early as the time of Herodotus, but they were not put to any great practical purpose until around 1799, and then by an unassuming man with an unassuming name — William Smith. Index fossils label strata, often much more honestly than trade-marks label merchandise.

There is a lure to geology greater than that of the antiquarian because it goes so incalculably farther back. But, unhappily, geology cannot be studied from the windows of an automobile going forty miles an hour. One has to walk, and very often the answers are most clear where the going is roughest. Great mountain systems, river canyons, and deserts are marvelous things to contemplate. They often supply us with great

Continued on Page Sixty-three

Institutum Divi Thomae

● By Reverend Cletus A. Miller
DEAN, INSTITUTUM DIVI THOMAE, CINCINNATI

It is the mission of the Church to bring the truth to men. She does not fear the advance of science. She does not desire that her members shall be kept in ignorance. She encourages them to participate actively in scientific work of all kinds.

As evidence of this we point to the recent establishing of the Institutum Divi Thomae by the Most Reverend John T. McNicholas, O.P., Archbishop of Cincinnati.

This graduate school, which is a unit of the Athenaeum of Ohio, is devoted to scientific research and to science education. It is attracting wide attention. Father Miller, its Dean, tells something of its organization and work.

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The universality of interest in all things human which has been characteristic of the Catholic Church from the beginning, has caused her to foster many enterprises that gave promise of bettering the physical or intellectual life of man. The precept of St. Paul, to be "all things to all men" has been observed throughout the centuries of her existence. One phase of this all-embracing philanthropy which is and always has been more prominent than any other is her effort to promote the secular education of mankind. It is only natural that this work should be so greatly cherished by the Church for it is closely related to her proper spiritual mission of presenting the revealed truth to man.

The cathedral schools of the first centuries gave instruction in all the departments of learning and, according to the testimony of the Fathers, despised not true learning regardless of the source. The monastery schools of the early middle ages brought civilization and culture to western Europe, and out of them grew the great universities, all begun and fostered by the Church.

This same endeavor the Church manifests today. Witness are her numerous schools and colleges and universities scattered over the four quarters of the world. In them the divine truths are presented and all helpful and ennobling learning is disseminated. It is true that today she is not the sole custodian of secular learning as she was for many centuries, for others have fallen heir to her institutions, or, profiting by her example, have rivaled her with ampler means in the magnitude and extension of this work.

Wholly false, therefore, is the opinion that the Church has endeavored to keep her members in ignorance and that she dreads the advance of science with fear for her own existence. But if science brings truth, then she can only welcome science, for her mission is to bring the truth to men.

Under these auspices and, as but another phase of this vital activity, His Grace, the Most Reverend John T. McNicholas, O. P., Archbishop of Cincinnati, formed in 1928 the Athenaeum of Ohio. This university chartered by the state, while yet modest in its beginnings, has for its purpose the promotion of religion, education, science and the fine arts. It has been the long-cherished wish of this prominent churchman that the position of the Church with regard to science should be made more evident to the world by an active participation in scientific work of institutions maintained by her. For this reason, when the opportunities were ripe, there was formed under his direction a fifth unit of the Athenaeum, a graduate school, devoted to scientific education and research. This unit, the Institutum Divi Thomae, was formally opened on June 1, 1935, at Mount Washington, Cincinnati. The direction of this school was entrusted to Dr. George S. Sperti, who was recently honored by His Holiness, Pope Pius XI, with membership in the Pontifical Academy of Sciences. The general philosophy of education adopted by the Institutum is that of the mediaeval schools, and therefore its Latin name. The Institutum Divi Thomae has been placed under the patronage of St. Thomas Aquinas, perhaps the clearest thinker of all times, for it is the purpose of the Institutum to investigate by means of scientific research the basic laws of nature and to interpret the findings according to the practice of Christian philosophy as propounded by the eminent and Angelic Doctor.

The methods of teaching are those used in the ancient schools. A few students working under the professor to whom they have been assigned are given individual instruction. They attend a limited number of formal classes, but the majority of their work and tutoring is in the laboratories where each group has definite problems to solve, and their instruction revolves about the field of science in which they are specializing. Each student is expected to obtain a very thorough and specific knowledge of the field in which he is majoring, but he is also expected to acquire a comprehensive understanding of all the sciences. The research of each of these small groups is co-ordinated with a general plan whereby each one is enabled to study the problems in his own field of science and at the same time further the research which is being carried on by the laboratory as a whole. Each research professor, together with the students assigned to him, attack a scientific problem from the angle in which they are interested, the whole research program being co-ordinated in all its parts by the Director. This system

Continued on Page Fifty-eight

Seed Germination

● **By Sister Mary Ellen O'Hanlon, O.P., Ph.D.,** *(University of Illinois)*
CHAIRMAN, DEPARTMENT OF BIOLOGY, ROSARY COLLEGE, RIVER FOREST, ILL.

Here is an interesting study of seed germination made by a teaching Sister who is well known in the field of biology. She is co-author with Rev. U. A. Hauber of a new textbook in biology for colleges (published recently by F. S. Crofts & Co., New York).

A class can gain valuable information from the study of germinating seeds and from young growing seedlings. Sister Mary Ellen discusses methods and materials in a practical and helpful way.

This paper contains many suggestions for the wide awake teacher of biology.

The figures used to illustrate this paper were drawn from life by Miss Verna Schultz.

●

All of us, whether young or old, are moved at the sight of very young things—whether the loveliest and at the same time the most helpless and the highest exalted of God's earthly creatures—a human child, or some of the lowlier of living things. Our admiration is attracted and an appeal is made to our finer emotions when we see a brood of newly-hatched chicks or of baby ducklings, and strange, indeed, would be the one who would not take a second look at a family of scampering young squirrels or chubby furry puppies. The young of some of the more repellent and even ferocious animals make a more sympathetic appeal than their elders.

Relatively few persons have those same emotions stirred at the sight of young seedlings just peeping through the ground. Only the well-initiated botanist or the long-experienced gardener ever gives these struggling young things much attention. Even the latter is not so much concerned with what happens down in the dark damp soil once he had planted the seeds, only that it does happen. Not until after the appearance of that part of the plant which is designed to ascend to the light of day and to bathe in the light and warmth of God's sunshine does he know that some very wonderful things have already taken place in the depths of darkness, and that various other marvelous processes will carry on there if only he will see to it that the soil is rightly aerated and that the water supply is sufficient. The gardener's index to progress is that which he can observe in the open.

Strictly speaking, the word germination, "budding," means the formation of the seed, the essential of which is a young plant. However, the common use of the expression "seed germination" has reference to the escape of this embryonic plant from the integuments of the ovule, which together with the stored food in the form of cotyledons or endosperm constitute a seed. That is, the seed is the ripened ovule including its covers which make the testa of the seed.

The emergence of the young plantlet from the seed coat or fruit coat as in the case of the dry, indehiscent fruits such as the corn kernel, acorn, hazel nut, and the key fruits, might be likened to a very interesting story. And who is there who does not want to know the beginning as well as the conclusion of such a story? Moreover, every kind of seed or fruit which is planted tells a different story, however much certain species may resemble each other, as is the case with closely related plants.

All of the processes concerned with the development of the young plant within the walls of the ovule are accomplished while the latter is still attached to the parent plant, and simultaneously with the development and ripening of the fruit which envelops it. This development, except in very special cases, is a result of pollination followed by fertilization. It depends upon the activity of the fertilized ovum within the embryo sac in the ovule.

And this brings us to the beginning of our story. The embryonic plant in the seed ordinarily develops from this single fertilized egg cell by repeated divisions and differentiation of the tissues thus formed until, even in the quiescent seed, we are able to distinguish that part which is destined to become the root from that which will become the shoot. It is the parent plant which provides the necessary food and moisture for the developing embryonic plant. At the same time it packs a goodly store, a dowry, as it were, for the future use of the young plant when it prepares to leave its narrow home and start in the independent life which it is destined to live. This time of departure, the so-called germination of the seed, may be sooner or later according as there are certain kinds of seeds which must undergo an after-ripening process subsequent to their dispersal. Thus, tucked away with their store of provisions inside their protective coats, such embryonic plants may lie dormant, in some cases for many months, even years—defying heat and cold, desiccation, and many of those conditions which are ordinarily so destructive to life. They maintain their viability until the time is propitious for them to make a new start in life. There are other extreme cases, for example, the seed of the citrus fruits which must make their independent start in life very soon after being freed from the fruit, or they will languish and die within their prison walls.

A consideration of seed germination, that is, the escape of the already well-formed plantlet from the seed coat, if rightly understood, should include many points of exceeding interest and might well be treated as a center to and from which radiate practically all of

the interesting phases ordinarily demonstrated in the life cycle of a typical seed plant. For it concerns itself not only with the emergence of the young plant but also with the many whys and wherefores of what happened previously and of what will happen after this important event in the life of an individual plant. The inquiring mind naturally wants to know the kind of fruit which enveloped the seed, the sort of flower which was the forerunner of such a fruit, the nature of the plant which bore it, how it differs from other unsuspected seeds which deliver plants strikingly individual; why some seedlings bear only one, some two, and others even several cotyledons; why the cotyledons in some germinating seeds never emerge; why in certain seeds, for example, the date, the cotyledon emerges but remains below the surface; while in others, as in the bean, the cotyledons are carried aloft on the young stem only to wither away and fall off; whereas in a fourth type they become green and function as foliage leaves though they differ quite markedly from the true leaves in both form and structure.

CONDITIONS FOR SUCCESSFUL SEED GERMINATION

Some of the most successful points to observe in germinating seeds are the conditions under which this process is most expeditious and satisfactory for the purposes of instruction. Despite the differences in seeds from the many varieties of plants, well over one hundred thousand species, there are certain environmental conditions that are essential for successful seed germination in all cases. These are sufficient moisture and a supply of oxygen for the greatly increased respiration and other enzymatic activities incident to the process. The amount of required moisture and the length of the germination period vary greatly with the different species according to the nature and permeability of the seed or fruit coat, just as the optimum temperature conditions will vary with the natural habitat of the particular plant. Many experiments have been tried by plant physiologists with seeds which seem to require particularly long periods of dormancy before they will naturally germinate, such as alternate immersions and dryings, sudden exposures to heat and cold, the use of various chemicals, and even mechanical devices such as pricking the seed coat with a sharp instrument or the complete removal of a particularly impervious seed coat. There are, however, many kinds of readily available seeds which require no special treatment nor extraordinary methods for successful germination which will furnish an abundance and good variety of illustrative material for class work.

In order to make the most of the valuable instruction which germinating seeds and young growing seedlings offer, it is best to make a series of set-ups using some of the same kinds of seeds planted a few days or weeks apart, thus providing several important stages for study.

The first stages in seed germination and subsequent development of the young seedling may most easily be observed when the seeds, after being soaked in water, are placed in a moist atmosphere; if they are supported by wads of moist paper, fine sawdust or other highly absorbent substance, they will orientate themselves in the natural way and their young roots will penetrate this kind of substrate. Such seedlings are not too difficult to remove intact for examination. If the germination set-ups are kept under glass, the seedlings may be observed without disturbance and will provide most instructive material.

When the seedlings reach the stage when they must have access to the soil and the raw food materials that it contains, they can be transplanted into small flower pots, a few only of each kind being necessary for class demonstration. Whenever it is desirable to examine one of these young plants in toto, a pot may be broken and the soil washed away carefully, leaving the root system quite intact. Such a plant may be kept alive for some time by putting it into a glass bottle or vase as one might do with cut flowers. The root system can then be easily observed. These young plants can even be preserved entire and used for demonstration purposes indefinitely.

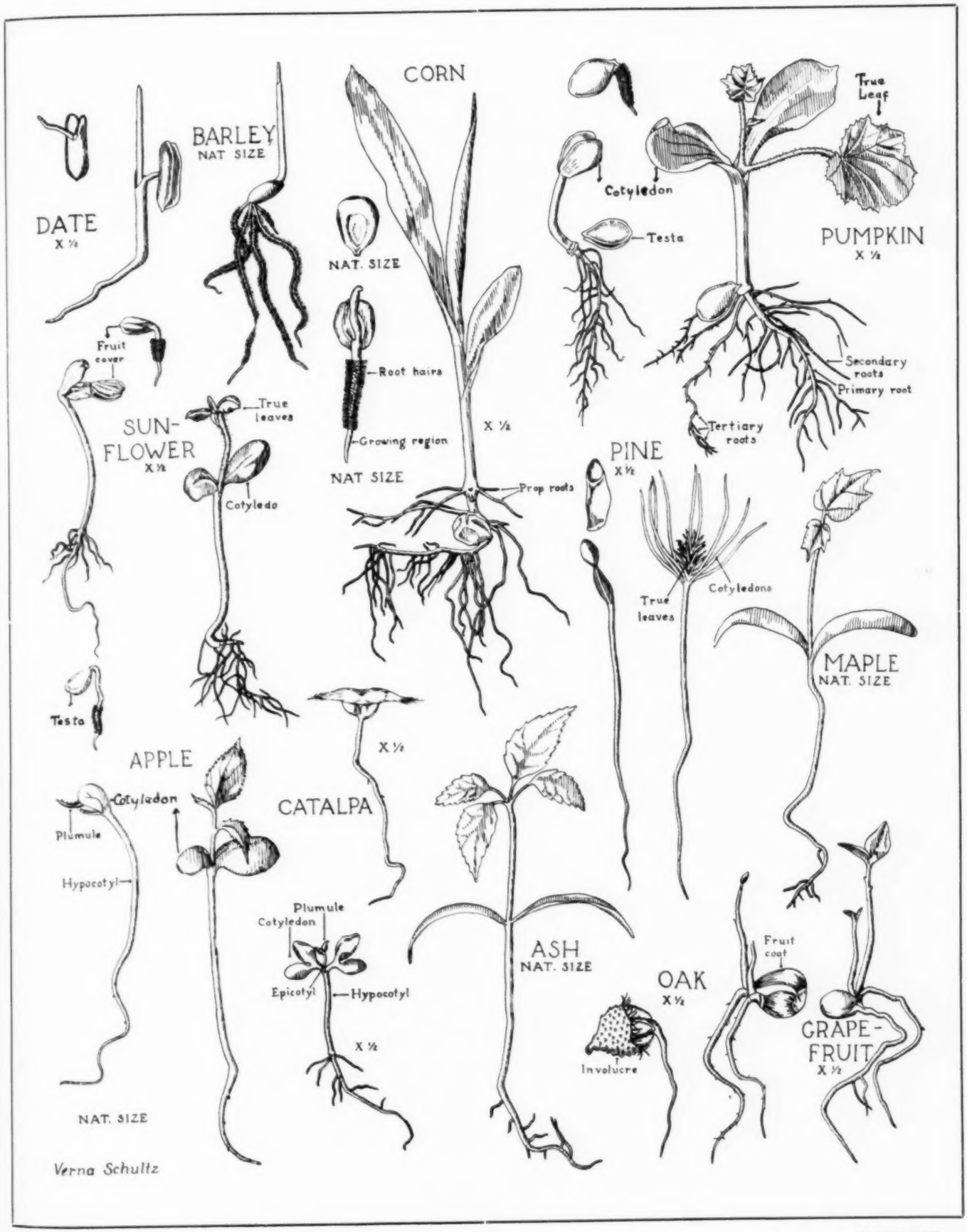
COTYLEDONS AND TRUE LEAVES

Seed germination readily distinguishes monocotyledons and dicotyledons in the two most uniform and decisive features which characterize these two groups. Monocotyledons bear but a single cotyledon and the young plant emerges laterally from the seed as in the date, corn or barley. The emergence of the young plant in the dicotyledons is apical and the characteristic number of cotyledons is two, rarely one, or more than two. Figures of the apple, sunflower, the ash, the maple and the pumpkin illustrate these features clearly. The catalpa's winged seed is definitely flattened and bears two bi-lobed cotyledons.

A young pumpkin seedling, for example, in addition to the two characters just referred to, shows in the emerging embryo the open veining of its true leaves and the cylindrical arrangement of the vascular bundles in the stem. If the picture of a typical flower of the pumpkin family (Cucurbitaceae) is added to this demonstration, the set of five distinguishing characters of the dicotyledons is complete.

Polycotyledony, which seems to be a primitive character, is the general condition in the conifers. This character is well and easily illustrated in the pine seedling which shows from seven to nine seed leaves. Pine seeds for germination may be obtained by collecting mature cones during the winter or in the very early spring before the cones open in order to disperse their winged seeds. Such cones picked from the trees and brought into a warm atmosphere will open, each bract, with a definite clicking sound, which may easily be heard in a quiet room. This sound is probably one of the very first voices that herald the coming of spring, and one which is not likely to be heard in the deep dark pine forest by any creature capable of making an intelligent interpretation of such music.

Any member of the pumpkin family will serve to demonstrate the type of cotyledons which come above


DATE
X ½
BARLEY
NAT SIZE
CORN
NAT. SIZE
Root hairs
Growing region
X ½
NAT SIZE
Prop roots
Cotyledon
Testa
True Leaf
PUMPKIN
X ½
Secondary roots
Primary root
Tertiary roots
Fruit cover
SUN-FLOWER
X ½
True leaves
Cotyledo
Testa
PINE
X ½
True leaves
Cotyledons
MAPLE
NAT. SIZE
APPLE
Cotyledon
Plumule
Hypocotyl
NAT. SIZE
CATALPA
X ½
Plumule
Cotyledon
Epicotyl
Hypocotyl
X ½
ASH
NAT. SIZE
OAK
X ½
Involucre
Fruit coat
GRAPE-FRUIT
X ½
Verna Schultz

the surface and function as foliage leaves in the process of photosynthesis; the hard dry fruit (akene) of the sunflower is also a good example of this feature and is equally easy and prompt to germinate. In the case of the bean, the cotyledons come above the surface of the soil but they soon wither and drop off, while its congener, the garden pea, holds its well-stocked food supply in the two hemispherical cotyledons which remain within the seed coat below the surface of the soil. This same condition holds for many seeds and is illustrated here in the figures of the grapefruit, acorn, corn, and barley. In such cases, the cotyledons absorb the endosperm and transfer it to the rest of the developing seedling.

Such cotyledons as are carried aloft, become green and take on the physiological functions of true leaves. They differ in form and structure from the true leaves which appear at the tip of the epicotyl. Such cases are well exemplified in the catalpa, the ash, the maple, the apple, the sunflower, the pumpkin and more pronounced still are these differences in the linden[1]. The true leaves and young stems of the pumpkin and the sunflower are quite hairy, but their cotyledons exhibit relatively little pubescence.

TROPISMS

Roots are both geotropic and hydrotropic and, therefore, immediately direct themselves vertically downward unless the source of moisture is located in another direction or because of some mechanical obstruction. The young stem, on the other hand, exhibits a negative geotropism and will normally grow vertically upward (except, of course, the horizontal stems such as stolons, runners, etc.). They will do this whether in the light or in the dark. When the young stem reaches the light, however, it immediately responds positively to this stimulus at whatever angle it may be necessary for it to turn, thus showing that its phototropic response is independent of and more potent than its negative response to gravity.

Seeds germinated in darkness exhibit the normal tropisms, but the young stem and leaves are unable to develop chlorophyll under such conditions and this state of etiolation of the young potentially green parts will incapacitate them for their work of photosynthesis. Such yellow seedings are doomed to death if left in the darkness. Any one who has turned over sticks or stones during the growing season has found various straggling yellow stems of such disadvantaged seedlings.

When we remember that what is at these stages definitely root and stem, with their distinct structural and physiological differences, were both derived from that single fertilized cell which took its origin in the ovule from which the seed developed, our questions multiply and their answers increase in difficulty. All these strange and interesting phenomena are more easily described than explained. The fact is that the ultimate causes of them are inexplainable in terms of science. All the scientist can do is to discover and to study the laws which govern the growth and activities of the many beautiful and mysterious things which God has created and endowed with such marvelous potentiality and manifestation of order and perfection.

[1] See Fig. 135, p. 132, Chamberlain, Elements of Plant Science, McGraw-Hill, 1930

ROOTS

The root habit of the adult plant is early foretold in the seedling. The barley seedling, for example, with its numerous rootlets typifies the grass family in which fibrous roots are characteristic. The young root of the pine seedling shows in its first stages the general habit of the adult. The corn seedling develops its prop roots early, while the secondary and tertiary roots of the young pumpkin plant suggest the more bushy habit of such a root system.

Young roots and rootlets, since one of their chief functions is the absorption of water and dissolved mineral salts from the soil, develop epidermal hairs in order to increase their absorbing surface. These root hairs are developed in greater profusion according as the growing medium is less moist. Rootlets suspended in a humid atmosphere readily develop a definite region of epidermal hairs. Immersed roots, on the other hand, will develop no hairs except in the root region above the water line; neither will root hairs develop in that relatively restricted part of the root that is actively growing by cell division. This actively growing region of the root is somewhat posterior to the tip and, like the root cap, it is also always free from root hairs. A simple experiment to show root hair development in a partly submerged root is figured in Chamberlain's *Elements of Plant Science*, page 60.

POLYEMBRYONY

Twins, of whatever kind, are always fascinating, and as the habit of twinning in animals is very rare in some groups but less so in others, and considered to be a heritable character, the same or rather parallel conditions seem to maintain in the plant kingdom. Actual twinning or polyembryony in plants is the condition in which more than one embryo is developed in a single ovule. This is a result of the fertilization of as many eggs, or because of the cleavage of a single developing embryo. The first case is called simply polyembryony and the second, cleavage polyembryony. There are other phenomena within a single ovule which are, strictly speaking, cases of polyembryony and could not be compared with the polyembryony or twinning phenomena in the animal kingdom. The citrus fruits, including the Florida orange, grapefruit, tangerines, lemons, etc., are notoriously polyembryonic, although it probably seldom happens that more than two embryos persist to the adult size. The figure of the twin embryos of the grapefruit seems to be typical of probably as many as sixty to seventy percent of the seedlings art this stage, even when a much higher percent initiate more than two embryos. Germinating acorns often seem to show what may be mistaken for poly-

Continued on Page Fifty-four

Manuals and Workbooks

In The Physical Sciences

● **By W. H. Kadesch, Ph. D.,** *(University of Chicago)*
STATE TEACHERS COLLEGE, CEDAR FALLS, IOWA

General Science, the newest of the high school group, is considered to be the most advanced of the secondary school sciences in organization, methods, and instructional aids. Benefiting by a study of the pedagogical shortcomings of the older sciences, General Science has struck out in new directions. The unit displaces chapter and topic, and the old laboratory manual gives way to the more effective workbook and directed study guide.

Dr. Kadesch discusses these newer aids, and shows how the other high school sciences are being helped by the pioneering work of teachers of General Science.

●

A motorist starting on a trip, whether just into the next county or entirely across the continent, will rarely be compelled to stop for directions anywhere along the way. A map obtained free at any filling station will serve him as a trusty general guide to the borders of the state where he may get another to carry him to the next state, while markers everywhere along the way serve to keep him going right and to warn him of narrow bridges and dangerous turns. These road signs will keep him constantly informed of the distance to the next town, of the condition of the road, if unusual, and often of the chief points of interest in the region. Our motorist need never to have traveled this way before. He will still be able to keep his course and arrive in due time without any long or unnecessary detours. He might with entire confidence even venture to serve as guide or driver to young or old who themselves are not motorists.

Thanks to many enterprising publishers and able writers, the teachers of science in our secondary schools are now in much the same happy situation with regard to their instructional journey. The young whom they assume to serve as guides may rest in confidence that if their leaders take full advantage of available directions, there need be little lost time on the way, no undue hardship, a pleasant and profitable journey, and a safe arrival. The maps and road signs of the educational tour are called textbooks, manuals, work books, and study guides. We deal here with the last three.

While General Science is the latest comer to the group of secondary school sciences, it is already the most advanced in point of organization and methods and quality of available instructional aids. Its progress in these respects has been particularly rapid in the last ten years.

The professed objectives of general science are much broader than those hitherto avowedly sought by the older sciences. They include not only factual knowledge, familiarity with principles, and at least a modicum of manipulatory skill, but also the development of desirable attitudes, ideals, and mental habits. One widely used guide book[1] mentions a four-fold objective as follows:

1. "An understanding of the elementary forces, materials, and phenomena of science necessary in the solution of everyday problems of social and civic significance.
2. Growth in the development of a scientific attitude of mind.
3. Growth in the ability to do critical thinking.
4. The development of wholesome intellectual interests and appreciations which lead to a desirable use of leisure time and which give a basis for educational and vocational guidance."

Another[2], in somewhat more general terms, says that "The study of general science has two main purposes; namely, to give the pupil an understanding of an important and pervasive aspect of our civilization, and to develop in the pupil the ability to solve such of his problems as are susceptible to scientific treatment."

In the pursuit of its objectives, general science has scrutinized the content and methods of the older sciences, and wherever feasible has adapted these to its own ends. After a sifting process in which a portion was retained and much rejected, it has added a great deal of new material which research has shown to be of gripping interest to the child. It has then organized the whole in such a way as to provide a psychological approach in which relationships and the significance of facts are accorded an importance at least equal to that of the facts themselves. Accordingly, in general science the Unit has come distinctly to the fore, and Chapter and Topic have almost disappeared.

In order to accomplish its purposes more easily and more interestingly, and therefore more effectively, general science has also developed certain new and effective aids. First, it has pretty completely transformed the traditional laboratory manual of the older sciences and breathed into it something of its own new life. Then it has brought forth the potentially effective science work book, and the equally important directed study guide.

The nature and thoroughness of the transformation that has taken place in the laboratory manual in order to make it an adequate instrument for achieving the purposes of general science is evident from a glance at any two representative manuals taken almost at random, one from the older type, and one from the new.

The laboratory manual came into use soon after the

introduction of laboratory work as a method of science teaching. Many such have been written. Until recently most of them were of one general pattern. A certain number of "Experiments" were outlined with "Purpose," "Materials," "Apparatus," "Procedure," "Data," "Computations" if any, and "Conclusions." In some instances forms for data were provided, sometimes per cent of error was called for, but there were no important variations from the usual order. The pupil followed directions, oftentimes with little to indicate that the experiment might have a value beyond the fact that it helped to satisfy one of the requirements for credit in the course.

The laboratory exercises of the modern course in general science offer a number of striking contrasts to the traditional manual of the older sciences. One important difference lies in the fact that in general science the experiments are presented not as so many distinct units, but as related parts of a larger whole. The pupil is thus enabled to glimpse the significance both of the larger problem and of each of its parts. Another difference, and a very important one, is the introduction of the problem by means of a question, as striking and pertinent as possible, instead of by a "purpose." This challenge is well calculated to catch the interest of the pupil because it presents a concrete problem and offers the prospect of adventure and perhaps discovery. When the authors of a certain set of laboratory studies[1], introduce the divisions of the general subject of electricity in communication by the questions:

"What is the principle of the telegraph?"
"What is the principle of the telephone?"
"How does the wireless telegraph work?"
"How does the wireless telephone, or radio work?"
"How are light and electricity joined to aid communication?"
"What is the principle of television?"

they are more likely to be given an attentive reading than if they followed the traditional form:

"Purpose: To study the telegraph," etc.

This interest is likely to be further developed when such sub-topics are announced as:

"To discover how a telephone carries the human voice."
"To discover how talking pictures operate."
"To discover how it is possible to 'see' by electricity."

The laboratory exercises of general science are preeminently inductive in character. The pupil is never directed to verify, but always, if possible, to discover. This he is encouraged to do by appealing to the experiment—"do this one thing, keeping everything else unchanged, and observe the effect." After a series of such observations he may be in a position to draw a conclusion or to state a minor principle. By such methods the spirit of exploration, the spirit of discovery which is characteristic of youth, is kept fresh. At the same time, by the use of appropriate controls and by limiting the conclusion to the scope warranted by the observations, a scientific attitude is fostered and scientific ability, the "ability to do scientific thinking," is developed.

General science workbooks are likewise designed not only to enable the student to acquire a store of factual knowledge concerning his environment, and an understanding of underlying principles, but also to develop a scientific attitude, an increasing ability to do scientific thinking, and the habit of using a scientific method in solving everyday problems.

Most workbooks, study books, or learning guides as they are variously called, are designed to be used in connection with a single textbook. Text and workbook together then supply the basic materials of the course, and provide a unified plan of instruction. The study guide constitutes a series of carefully worked out assignments, with constant provision for testing and recording the results of study. In addition to the exercises in which the subject is developed by means of carefully selected questions, there are frequently other lists which are intended to be used by the pupil as self tests. This device not only serves to enable the pupil to judge of his own achievement and progress, but tends to line him up with his instructor in a cooperative effort to widen his horizon and develop his ability.

Provision is made in various ways for exercising to the full the abilities of the gifted or especially interested pupil. This may be done by supplying home laboratory projects, supplementary reading references or extra credit exercises. In some instances the pupil is encouraged to record his own ideas[1], original they may be, and valuable, whether they have in them the germ of a new application of science to a useful practical purpose, or whether they only foster self activity, which, after all, is the only activity likely to lead to permanent gain in either knowledge or ability.

Pictorial aids are freely employed in both manuals and study guides. These may be informative, as when the familiar line diagram is used to illustrate a simple device or process, or when the content of a unit is epitomized in a single inclusive introductory picture. These diagrams and pictures also aim to motivate—to touch with life. Hence the pulley set, for example, will not be represented merely as a rope and a set of wheels, but will include also something of live interest, perhaps a boy tugging willingly at the rope in order to raise a load of boards up into a tree where his playmates are building them into a lodge.

In the older sciences of physics and chemistry there has recently been a marked advancement in the character of available instructional aids. First came improvement in the laboratory manual. A couple of new headings edged their way into position in the list which formerly included only "Purpose," "Materials," and the other items familiar to all users of the older manuals. These new headings greet the young traveler on the educational road as "Questions," and "Exercises." They are designed to help him become better acquainted with the road or to disclose any inadvertent wanderings. Sometimes they serve to direct a little side tour to a point of special interest or importance. They are

Continued on Page Fifty-seven

Air Conditioning the Home

● **By Catherine Mary Melanson**
ST. CHARLES HIGH SCHOOL, WALTHAM, MASS.

A committee of the science and English faculties of Duquesne University chose this essay as the best of those submitted in the national contest for students in Catholic high schools, conducted in connection with the University's annual Conference for Teachers of Science.

Miss Melanson's essay was written under the direction of Sister Annisa of the Sisters of St. Joseph. It has not been edited.

Honorable mentions of equal value were given to Florence E. Thein, Bishop McDonnell Memorial High School, Brooklyn; Mary Helen McCann, Mercy High School, Chicago; Frances Marie Gage, St. John High School, Fresno, Cal.; Dorothy E. Kearns, Bishop Toolen High School, Mobile, Ala.; and Marie Schoepflin, St. Francis Academy, Pittsburgh.

●

For the past few years the science of Air Conditioning has been observed with keen interest by many people, not only in technical magazines but also in the public press.

It may be defined as the "science of controlling the temperature, humidity, motion and cleanliness of the air within an enclosure."

Although this term "Air Conditioning" may be somewhat new to us, it comprises nevertheless, a combination of principles known to man for many ages. Take for example, the ancient Roman and Greek monarchs, who, during the hot weather, surrounded themselves with slaves waving fans to and fro over their heads. Then, archaeological research has revealed to us that ancient Roman baths were heated by fires built in vaults below the floors. In later years, the fireplace, the cast-iron stove, given to us by Benjamin Franklin, steam and the much improved oil burning boilers, were simply milestones on the road to provide us with bodily comfort and health.

But, with the advance of science, man has opened up new paths in the field of air conditioning. Complete air conditioning involves warming or cooling the air, purifying it with ozone or fresh air and removing dust. The average house, however, does not need complete treatment of the air to improve conditions in regard to health and comfort. The most dangerous condition existing in the average home is dryness. This, however, can easily be remedied by humidifiers, which are used to add moisture to the air in a heated room. Stagnant air, another source of discomfort, may be correected by circulating the air with fans or using the system of ventilation, which may be described as the "science of maintaining atmospheric conditions which are comfortable and healthful to the human body." The medical profession too, has declared that humidification during the hot season, is a protection against colds and other diseases and infections. And besides being healthful and sanitary, it also adds greatly to our bodily comfort.

CATHERINE MARY MELANSON
ST. CHARLES HIGH SCHOOL,
WALTHAM, MASS.

Developments have taken place very rapidly both in the use and production of air conditioning equipment for houses. In fact, its progress has been so great, that a house to be thoroughly "modern" must provide for air conditioning, and at the present date there are many types of equipment available for the house. The principles involved are:

1. Heating and humidifying.
2. Heating, humidifying, air cleaning, and circulation.
3. Cooling and dehumidifying with or without air cleaning.

In order to obtain a clear knowledge of the various operations which are employed to make up complete air conditioning, I quote "The American Home" which states:

"Air conditioning systems are controlled by automatic devices; thermostats are used for the precise regulation of temperature; humidity may be controlled by humidostats or hygrostats; air motion by pressure regulations governing the fan or blower mechanism."

In a theoretical air conditioning machine, the air in each room is drawn through openings in the baseboard near the floor which are screened by a metal grille. A motor is used to draw the air from the rooms and force it through the conditioner and once again throughout the house.

When the air enters the centrally located machine in the basement, it passes through filters which remove the dust and dirt. Then, after the air has been cleaned, it passes through a system of coils where it is warmed to the temperature desired, by means of a gas burning unit.

Moisture is then added to the heated air by passing it through the humidifying unit. The air is then cleaned and humidified by spraying water over filter packs.

The warmed and humidified air is then forced in the blower and distributed to the various rooms, eftering them through grilles, similar in character to those used for the intakes.

In addition to the equipment employed

Continued on Page Sixty

The Story Of An Old Book Cover

● **By Sister Mary F. Xavier, S.S.N.D.**
MOUNT MARY COLLEGE, MILWAUKEE

This story is largely a translation of the parchment manuscript cover of a tattered medical book, published in 1574, which is now treasured in the library of the University of Wisconsin. The story on the cover has nothing to do with the contents of the book. The parchment, selected by chance, was pasted on long ago merely to help keep the volume together.

Dr. Kremers, who is greatly interested in the apothecary in literature, called this rare book to Sister Xavier's attention while she was studying for a degree in chemistry at the University. Her interest was aroused, and the work of translating the cover was begun.

Here is a "different" story, which while not scientific in the usual sense, will, we feel, be of great interest to our readers. As Dr. Kremers has said, science sometimes needs a bit of humanizing.

●

FOREWORD

● **By Edward Kremers, Ph.D., D.Sc.**
THE UNIVERSITY OF WISCONSIN

Strictly considered, this account of an old book cover related by Sister Xavier does not fall under the general caption "The apothecary in literature." Yet, in a way, it is closely connected with the subject. The book in question is an original copy of Jost Ammon—Hans Sachs' "Beschreibung aller Stände auf Erde." and constitutes the rarest treasure of the writer's collection of the apothecary in literature. By a piece of good fortune he secured it many years ago. Some time thereafter, he reproduced the cuts by Jost Ammon of both physician and apothecary and quoted the rhymes by Hans Sachs pertaining to the apothecary. Both cuts and rhymes have been used not infrequently by lovers of our pharmaceutical past.

The parchment manuscript cover of the book naturally attracted the writer's attention when first he held the tome in his hands. In its way, the binding was as rare a treasure as the original imprint of the volume. Busy with the manifold duties of instructor and administrator, he put off the deciphering of the manuscript from year to year. One day when he met Sister Xavier in the library, it occurred to him to show the volume to her, knowing her interest in the classics and in literature, more particularly in the Latin of the Middle Ages. She at once appreciated the rare significance of the book and deciphered the text of the manuscript cover. It is her story which follows.

The publication of her enthusiastic story seems fully as much worth while as the writer's matter-of-fact account of the apothecary of the text. The scarcity of the volume as such is revealed when the reader is told that the recently established Department of the History of Art at the University could not obtain an original, but had to content itself with a reprint. The parchment manuscript cover of the copy in question renders it unique among the copies extant.

●

THE STORY

It is an old volume, "Gedruckt zu Franckfurt am Mayn, im Jahre MDLXXIIII," entitled "Eigentliche Beschreibung: Aller Stände auf Erden/ Hoher und Nidriger/ Geistlicher und Weltlicher/ Aller Künsten/ Handwercken und Händeln/ u. vom grössten bis zum kleinesten"; and portraying one hundred and fourteen "walks of life," with quaint old wood cuts by Jost Ammon illustrating the rhymes of Hans Sachs.

Pliny has said: "There is no book lightly so bad but that some good thing a man may pick out thereof." If this be true of a book which is not good, it is very much more true of one which is good, as is the book whereof we speak. There are many "good things" to be picked out "from within" this book,[1] but the outside is, in itself, a precious thing. The cover is a piece of parchment, whereon has been wrought by hand a gospel story—the story of the raising of Lazarus from the dead, and the assurance of Christ of the resurrection of the just *unto life eternal* on that last day. The letters are typical of the old Latin manuscripts, and are perfectly executed with painstaking care. Many of the words are written in an abbreviated form, characteristic of mediaeval Latin.

To the lover of Latin and the lover of romance the old manuscript is interesting beyond measure. The casual reader may see no connection (and most probably none is intended to exist) between the contents of this book and the narrative on its cover, and yet there is a striking relation.

The book reveals, like "the scroll of life unrolled," the story of life ending in death; the cover reveals the story of death ending in Life. Reading the pages of this book is like going through a fairy wood, meeting fictitious characters, giving one a keen relish for life, but always conditioned by the expectation of a Lasting City at nightfall.

In the *Vorrede* we read "Wünsche ich Sigmund Feyerabend/ Glück, Heyl, und ewige Seligkeit." How beautifully this "ewige Seligkeit" is expressed in the story on the cover, words used in every Christian burial service: *Ego sum resurrectio et vita: qui credit in me, etiam si mortuus fuerit, vivet: et omnis qui vivit et credit in me, non morietur in aeternum.* To believe in Our

[1] Kremers, E., *The Apothecary in Literature*—No. 1.

Lord is to believe that death is life. For faith is vain, indeed, if it does not make of death a little thing—yet of great value and greatly to be desired, as the door which opens unto Life.

"Unless Thou lovest us, what availeth this life that we live? And unless Thou lovest us, life were blackness and confusion, a stumbling about amid shadows, and a falling away into night."

Faith, moreover, holds out to us not only the hope of a blessed resurrection, "that they who are saddened by the certain necessity of dying be comforted by the promise of eternal life to come," but also the assurance that the life of the faithful is not destroyed by death, but changed—"et dissoluta terrestris hujus incolatus domo, aeterna in caelis habitatio comparatur."

The *Beschluss* of the book reads (in part):

"Wer aber führt ein bösen Handel Unnütz/ Gottlos/ diesen Wandel
So entgeht er viel ungemachs
Hie und auch dort/ spricht Hans Sachss."

"Auch dort" very probably refers to the life hereafter, where Divine Justice will inflict punishment on the doer of evil deeds. The story on the cover, though it ends abruptly before the end of the chapter, comes to a close on the same note of the life to come, but in marked contrast. The conclusion of the book itself, as above quoted, is a warning, almost a threat; whereas the cover of the book emanates joyful expectancy in the final words of its message of hope: *"Nonne dixi tibi quoniam si credideris, videbis gloriam Dei"*

Who wrote the story on the cover, and when, and where? Undoubtedly, the parchment is much older than the book. Perhaps a youthful monk or nun in some silent cloister cell; perhaps an aged religious, waiting for "Sister Death" (as Saint Francis blithely styles her)—longing for the summons: *Magister adest, et vocat te*, even as with trembling hand he traced those self-same words in the manuscript - - - -

The *story* follows. The gospel narrative, as deciphered from the writing on the cover of the book, reads thus:

. . . . in novissimo die Dixit ei Jesus Ego sum resurrectio et vita qui credit in me, etiam si mortuus fuerit vivet Et omnis qui vivit et credit in me non morietur in a e t e r n u m Credis hoc Ait illi Utique Domine ego credidi quia tu es Christus filius Dei vivi qui in hunc mundum venisti Et cum haec dixisset abiit et vocacit Mariam sororem suam silentio dicens Magister adest

. . . . at the last day. Jesus said to her: I am the resurrection and the life: he that believeth in me, although he be dead, shall live: And every one that liveth and believeth in me, shall not die forever. Believest thou this? She saith to him: Yea, Lord, I have believed that thou art Christ the Son of the living God who art come into this world. And when she had said these things, she went and called her sister Mary secretly, saying: The Master is come

(The next two sentences of the gospel are no longer visible, as the back of the book has been lost.)

The story on the cover continues:

sed erat adhuc in illo loco ubi occurrerat ei Martha Judaei ergo qui erant cum ea in domo et consolabantur eam cum vidissent Mariam quia cito surrexit et exiit secuti sunt eam dicentes quia vadit ad monumentum ut plorat ibi Maria ergo cum venisset ubi erat Jesus videns eum cecidit ad pedes ejus

but he was still in that place where Martha had met him. The Jews therefore who were with her in the house, and comforted her, when they saw Mary that she rose up speedily and went out, followed her saying: She goeth to the grave to weep there. When Mary therefore was come where Jesus was, seeing him, she fell down at his feet

(Beginning with the next words, one cannot follow the entire text, as the parchment has been turned in and another paper pasted over it. From the words which do appear, however, it is not difficult to see that the narrative continues without interruption. The complete text follows, with those words in italics which one is able to read in the manuscript.)

et dicit ei Domine **si fuisses** *hic non esset mortuus* **frater** *meus Jesus ergo* **ut vidit** *eam plorantem* **et Judaeos** *qui venerant* **cum ea** *plorantes infremuit* **spiritu et** *turbavit seipsum* **et** *dixit Ubi posuistis* **eum** *Dicunt ei Domine* **veni et vide** *Et lacryma*tus **est Jesus** *Dixerunt ergo Judaei* **Ecce quomodo** *amabat eum* **Quidam** *autem* **ex ipsis** *dixerunt* **Non** *poterat hic qui* **aperuit oculos caeci nati facere ut hic non moreretur Jesus ergo rursum fremens semetipso venit admonum***entum erat* **autem spelunca** *et lapis super***positus erat ei** *Ait Jesus* **Tollite** *lapidem Dicit* **ei Mar***tha soror ejus* **qui mortuus** *fuerat Domine* **jam foetet** *quatriduanus* **est enim Dicit** *ei Jesus Nonne d***ixi tibi** *quoniam si crede***ris videbis** *gloriam Dei Tule***runt ergo** *lapidem Jesus autem* **elevatis** *sursum oculis. . . . .*

THE END

and saith to him: Lord, if thou hadst been here, my brother had not died. Jesus, therefore, when he saw her weeping, and the Jews that were come with her, weeping, groaned in spirit, and troubled himself and said: Where have you laid him? They say to him: Lord, come and see. And Jesus wept. The Jews therefore said: Behold how he loved him. But some of them said: Could not he that opened the eyes of the man born blind have caused that this man should not die? Jesus therefore again groaning in himself, cometh to the sepulchre. Now it was a cave; and a stone was laid over it. Jesus said: Take away the stone. Martha, the sister of him that was dead, saith to him: Lord, by this time he stinketh, for he is now of four days. Jesus saith to her: Did not I say to thee that if thou believe thou shalt see the glory of God? They took therefore the stone away. And Jesus lifting up his eyes. . . . .

The Cost Of Equipping A High School Chemical Laboratory For The Semi-Micro Method

● **By Sister M. Lawrence, R.S.M., M.S.,** *(Catholic University)*
MOUNT MERCY ACADEMY, PITTSBURGH

and William J. Schiller, Ph.D., *(University of Pittsburgh)*
MOUNT MERCY COLLEGE, PITTSBURGH

The article on "Semi-Micro Methods for High School Chemistry" which appeared in THE SCIENCE COUSELOR *in September of last year, attracted considerable attention from teachers and administrators. A frequent question has been, "What will it cost?" Here is the answer.*

This article tells what it actually did cost one school to equip a laboratory with chemicals and apparatus.

The authors again generously offer to help in whatever way they can, anyone who is interested.

Dr. Schiller is co-author of a recently published book on semi-micro methods.

●

Since we published our previous article on Semi-Micro Chemistry† we have received requests for an estimate of the expense involved in starting a laboratory for semi-micro chemistry in a high school.

To those who have not read the article referred to, or who are not familiar with this newer development, a definition of the scope of the subject is necessary. The semi-micro method applied to the teaching of chemistry means the utilization of *small-scale* methods in the carrying out of experiments. The microscope is not used. The methods employed, the small place required, the small amounts of chemicals needed, the removal of most of the dangerous features of the macro- or large-scale methods, the possibility of time saving, and the very fact that semi-micro methods are "in the air," make this newer method extremely desirable for high school laboratories. It should be noted, also, that college laboratories are adopting this system.

In presenting an itemized expense list, we are extremely fortunate in being able to tabulate the equipment and materials which actually were purchased by a school laboratory which started from "scratch." At the beginning of the present school year St. Casimir's High School, Pittsburgh, organized and began to conduct a course using semi-micro methods. At the start, the only equipment available for laboratory purposes was one laboratory desk equipped with two sinks. Gas connections had been installed at this desk. With a room 12′ x 36′ containing the foregoing equipment, and with accommodations for only ten students, it was necessary to take care of a class of twenty. At our recommendation, Sisters Antonio and Ernestine decided to install the necessary equipment to conduct the course on a semi-micro basis. A careful record was kept of all expenses incurred in equipping the laboratory.

The items listed below represent the expense involved.

For the sake of clearness, the items have been divided into two groups.

EQUIPMENT

Quantity	*Apparatus*	*Cost*
6 gross	Test tubes (Fermentation), 2cc.,	$ 10.80
3 gross	Dropping bottles* ¼ oz.—8cc.,	7.50
1 gross	8 oz. bottles with rubber stoppers, narrow mouth,	7.00
1 doz.	Micro burners,	4.80
1 doz.	Wing tops, for burners,	0.55
1 doz.	50cc. Erlenmeyer flasks,	1.92
1 doz.	2-hole rubber stoppers, to fit flasks,	0.10
6 gross	Corks, to fit fermentation tubes, No. 1,	2.10
1 doz.	100cc. beakers,	2.16
1 only	Hand micro-centrifuge,	10.00
½ gross	Centrifuge tubes, 36 large—3cc.,** 36 small—2cc.,	1.80
2 doz.	Rubber bulbs, for medicine droppers,	0.40
2 doz.	Watch glasses (1½—2 inches),	0.54
2 doz.	Porcelain crucibles, 10cc., No. 00,	2.88
2 doz.	Crucible tops to fit No. 00,	1.44
2 doz.	Length of glass tubing, 4mm. O.D., 2 lb.,	1.00
2 doz.	Length of glass tubing, 6mm. O.D., 4 lb.,	1.40
4 doz.	4 dr. vials (about size of vials for litmus paper), with No. 4 corks,	1.00
2 doz.	Glass-stoppered dropping bottles, 30cc.,	5.28
1 doz.	Packages of small labels,	0.75
1 doz.	Dry cells, for electrolysis,	3.60
1 gross	Rubber stoppers, to fit 8 oz. narrow mouth bottles,	
1 doz.	Rubber tube connections for burners 3/16",	2.88
1 doz.	Drying tubes,	1.44
12 ft.	Rubber tubing 3/16", inside diameter,	0.60
2 doz.	Length of glass rod, 5-6 mm. D. 4 lb.,	1.60
1 doz.	White spot plates, No. 00,	5.40
1 doz.	10cc. graduates,	2.40
2 doz.	Charcoal blocks	1.00
1 doz.	Rules in centimeters and inches,	0.96
4 only	Horn pan balances, 6",	5.60
4 sets	Weights, 10 mg. to 50 g.,	9.00
4 doz.	4-inch test tubes,	0.50
1 doz.	Mohr 1cc. pipette, (graduated to 0.01cc.),	2.88
1 lb.	Nickel wire,	1.50
1 doz.	Screw clamps,	1.44
1 doz.	Pinch clamps,	0.96
1 ft.	Platinum wire (for flame tests)	4.68
3 doz.	00—Rubber stoppers (1-hole) to fit 4" test tubes,	0.20
1 doz.	Blow pipe tips,	1.00

Continued on Page Fifty-eight

*Kimball Glass Company
**Mellon Institute

† *Science Counselor*, Vol. II, No. 3, p. 71.

You Should Read

●

Senior Science

Socialized for the High School

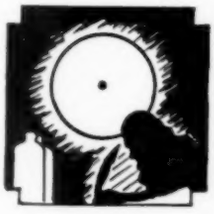
● *By* GEORGE L. BUSH, South High School, Cleveland, and THEODORE W. PTACEK and JOHN KOVATS, JR., both of the John Adams High School, Cleveland. New York; American Book Co., 1937. vi + 835. Illustrated. $2.20.

Here is a new type of textbook, different in purpose, appeal, content and format. It deserves careful consideration.

In a sense, this book provides a "general science" course for senior high school pupils. Concerned with the practical aspects of science rather than with the theoretical, it will give to those who study it a large amount of valuable information not otherwise readily accessible. Although it makes free use of the subject material of physics and chemistry, it does not attempt to supplant them. It makes its especial appeal to those somewhat mature students who will not go to college, and who are about to complete commercial, home economics, shop or other non-academic courses of which physics and chemistry are not usually a part. The ten units of the book deal with Water, Fire, Fuels, Weather and Air, Food and Medicine, Textiles, Building Materials, Home Equipment, Transportation, and Safety.

The ultra-modern format is attractive. Binding, paper, type faces, and illustrations, all are well chosen. Its weight of more than three pounds may annoy the lazy pupil, but the wide-awake student will find much useful scientific information within its well designed covers.

H. C. M.



A Laboratory Manual of Vertebrate Embryology

For Colleges and Universities

● *By* HUBERT VECCHIERELLO, O.F.M., Ph.D., Professor of Biology and JOHN L. WORDEN, M.Sc., Ass't Professor of Biology and Professor of Histology and Embryology, St. Bonaventure College, St. Bonaventure, N. Y., published by St. Anthony Guild Press, Franciscan Monastery, Paterson, N. J. xvii + 92; 235 illustrations. List price $2.50, less 40%.

The section on the chick is adequate and very well done. The development of the frog, however, is practically omitted and this is difficult to understand, in that its embryological processes are easy to follow and serve to throw light on parallel processes in larger-yolked forms; besides, frog material is plentiful and readily obtainable. However, as each embryologist aims at certain special objectives in his course, there may be some reason for this omission.

The manual includes some cytological diagrams that would be more in place in a text than a manual. The drawings on mitosis are too diagrammatic if intended for use with slides.

Msgr. George Barry O'Toole.

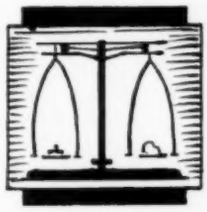
Down to Earth

● *By* CAREY CRONEIS and WILLIAM C. KRUMBEIN, of the department of geology at the University of Chicago. Chicago; University of Chicago Press, 1936. xi + 501. $3.75.

The University of Chicago Press presents another of its pioneering textbooks which it offers for use especially in survey courses in the several sciences. This is probably the most interesting of the group yet to be published. Scientifically accurate, but not too technical for the average reader, this book should find a place as a handy reference book in geology for high school and college students. Every teacher of science can read it with profit.

The unusual format of the book is attractive. It is copiously illustrated with diagrams, cartoons, and 64 rotogravure plates, probably the first ever to be used in a textbook. The formal textbook style of writing is absent. The authors have made a real effort to make their story interesting as well as informative.

H. C. M.



General Psychology

An interpretation of the Science of Mind Based on Thomas Aquinas.

● By ROBERT EDWARD BRENNAN, O. P., Ph.D., Professor of Psychology, Providence College. The Macmillan Co., New York, 1937. xxxvii + 507. $3.00.

This is an adequate Catholic text, which does not try to tone down the principles of Scholastic philosophy to a point where they resemble mechanistic formulas. Father Brennan is not ashamed to be an out-and-out Thomist, and for this he deserves our sincere congratulations.

Msgr. George Barry O'Toole.

Seed Germination

Continued from Page Forty-six

embryony inasmuch as more than one seedling is produced by a single acorn. The fact, however, that the acorn is a fruit which develops from a several-ovuled ovary explains the production of more than one oak seedling from a single acorn. Such seedlings are as individual as any two distinct plantlets that might develop in seeds which are independently dispersed instead of being held together in this nut type of indehiscent fruit. Simple polyembryony as described above in plants may be likened to fraternal twinning in man; whereas cleavage polyembryony may be compared to identical twinning.

CONCLUSION

By way of summary and suggestion for the teacher who would derive the most instructive material for a class of students either in the high school or elsewhere from this very interesting process of seed germination, these points should be well considered:

1. The maturity of the seed which is to be germinated, that is, how soon after dispersal are the seeds ready to germinate.

2. To determine the optimum temperature and moisture conditions for each species. Observations of what happens in nature will help the experimenter in solving these problems.

3. The expected germination time; the date will normally require from six to eight weeks; whereas the pumpkin and its relatives will germinate the second day. The seeds of the acorn, the hazel nut, and the linden will require longer according as they are enclosed within hard fruit covers. However, germinating acorns may often be picked up late in the fall and brought indoors for further development.

4. The amount of soaking varies, of course, with the species, but for successful germination twenty-four hours is long enough for most of the common seeds; a longer period may be the cause of bacterial action in some, and suffocation in others. There are seeds, however, which will withstand a much longer submergence.

5. Light is not a factor for seed germination, and if the correct conditions of temperature and moisture are present, seeds will germinate either in light or darkness; but light is absolutely necessary for normal development of green seed plants subsequent to the appearance of the aerial portions above the substrate.

6. Observation of the number, the kind, position and functions of the cotyledons and a comparison of their persistence in different species as well as their form and texture as compared with that of the true leaves of the same species. A comparison, too, of the first true leaves with the leaves of the older plant is of interest. For example, the first pairs of young leaves of the ash are simple while the sapling and the adult tree have compound leaves.

7. The character of the young roots and their branching, and the consistency of these habits with those of the adult plants. Also, the conditions which increase or diminish the number and the region of root hairs and their position with respect to the growing region of the root.

8. What fruits and what seeds are likely, when germinated, to deliver more than one plantlet and when such cases are classed as true polyembryony.

When the answers to these questions cannot be found in the germinating seeds themselves, works on the taxonomy of floral organs and fruit and seed structures as well as treatises on the physiology of seed germination and of plants in general, will furnish the answers insofar as some of the questions are fully answerable by the scientist.

◆

Nun Receives Science Honor

Sister Mary Ellen O'Hanlon, O.P., Ph.D., Chairman of the Department of Biology, Rosary College, River Forest, Illinois, whose article on "Seed Germination" appears in this number, was recently honored by being elected to Sigma Delta Epsilon, graduate women's scientific sorority by the Gamma Chapter at the University of Illinois. The sorority furthers friendship among women engaged in scientific research and works energetically to further the cause of women workers in science.

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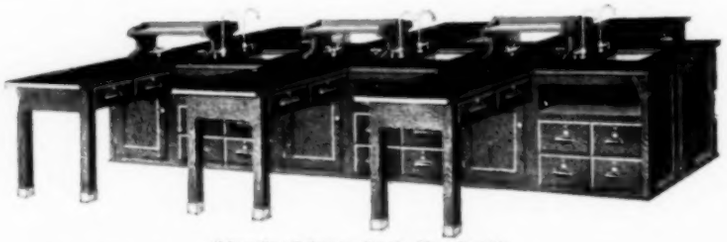
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Manuals And Workbooks

Continued from Page Forty-eight

always stimulating, and go far to vitalize these sciences.

Recently, of a sudden have come work books and study guides in these older sciences also. The former vary somewhat among themselves, some being designed to accompany a single textbook, others adapted for use with any standard text. In the former case the text and work book follow the same order. The latter then often serves as a perpetual questioner of the pupil, and sometimes as a real inspirer. In the first of these roles it may serve to reveal to him the extent of his mastery or failure. This presumes that he has first studied the assignment in the text or references and has then taken up the exercises, answering as well as possible without, for the moment, consulting any of the usual sources. If after this self test the pupil again returns to the text or references for confirmation, correction, or additional information, the work book is an aid of prime value. If he turns to the work book before making a study of the subject, either guessing at the answers to questions, or turning to the text or references for these answers one by one, writing them in the spaces conveniently provided, but without any or adequate cerebration, then he is robbing himself of a chance to become in any important degree a master of the subject, and the work book has been a definite obstacle. The authors of work books point out clearly the better ways of using these aids.

A further and more recent development is the study guide. In the older sciences, just as in general science, this serves as a series of carefully worked out assignments. In each assignment there may be definite references to sections of one or more textbooks. Lists of questions bearing on salient points of the assignment follow the reading directions. Usually spaces are provided for the brief answers required, as in the usual work book. Experimental work is outlined and explicit directions given. The interrogation point is very much in evidence following these directions, with "What?", "Why?", "How?", and sometimes "How much?" Thus, the study guide is a combination of work-exercise book and laboratory manual. It may be even more. In some instances the study outline is so complete and so well ordered that it may well share with the textbook the primacy of position traditionally accorded to the latter. Interesting stories and arresting cartoons are also freely used to introduce the various units. These then serve either to orient the student with reference to the subject matter covered in the unit, or to provide effective motivation.

Thus, the older sciences have become thoroughly awakened to their pedagogical shortcomings, and have already done a great deal to correct them.

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[1]Pieper and Beauchamp, *Teacher's Guidebook for Everyday Problems in Science*, Revised Edition, 1933, Scott Foresman & Co.
[2]Davis and Sharpe, *Science*, 1936, Henry Holt & Co.
[3]Wood and Carpenter, *Science Discovery, Book III*, 1934, Allyn & Bacon.
[4]See, for example, Hunter and Whitman, *Workbook for Problems in General Science*, 1934, American Book Co.

Visual Aids In Science

Continued from Page Thirty-six

draw tentative conclusions for conduct control.

7. A final test may cover the entire unit when it has been completed.

The motion picture "Simple Machines" is presented as a good example of effective use of visual aids in science education. A motion picture should be used where motion is essential to the understanding of principles, laws and theories. This picture brings to pupils examples that could not possibly be presented in the classroom in any other way. There are now available for the use of schools many such pictures.

This discussion has endeavored to direct attention to some types of visual materials valuable in science education, namely, museum materials, graphic presentation and pictorial representation. Such materials are rather definite primary sources as contrasted with the printed page which is secondary. These materials have value in attaining such objectives in science education as the ability to see clearly, to record accurately and to infer justly.

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Institutum Divi Thomae

Continued from Page Forty-two

effects a detachment in seeking truth which tends to exclude personal bias and will naturally inculcate a broader approach to every problem.

The faculty of the Institutum is composed of two distinct groups: The research staff which is permanent; and the teaching staff which comprises professors from its own and other colleges and universities who have excelled in their particular fields. The research staff devotes its entire time to the furtherance of scientific investigations; each professor conducts laboratory work in which he is assisted by the students whom he tutors in the science in which they are working. The teaching staff gives lectures in graduate subjects which are correlated with the research in progress. With this plan each student has the advantage of attending lectures in all branches of science. The studies and research work are all of a graduate nature.

After a student has devoted himself to research work and study for a period of three years, he is given a degree of Master of Science. The degree of Doctor of Science is given *honoris causa* to graduates who have distinguished themselves by outstanding accomplishments in teaching or in scientific research. Students are accepted only upon invitation. Since there are no fees for tuition, capable and interested students of science unable for financial reasons to pursue graduate studies, are offered an opportunity provided they meet with the requirements. Students are accepted without distinction of sex, race or creed. A limited enrollment enables the professor to give individual attention to each student. The administrative affairs are under the direction of the Dean, Reverend Cletus A. Miller.

At the present time most of the attention of the research staff is centered upon discovering the nature of compounds which are responsible for the stimulation of growth, fermentation and respiration of yeast cells in animal tissues in relation to the cancer problem. Another problem is on the absorption of vitamins through the skin; another deals with the growth of plants in the formation of essential plant pigments. The nature of the gene is studied and new methods for such work are being developed. An extensive research program dealing with tuberculosis is being inaugurated. Much of the medical work is done with the cooperation of prominent hospitals of the city.

The Institutum Divi Thomae is temporarily located in Mount Washington, a suburb of Cincinnati. Nearby, a new site of forty-one acres overlooking the Ohio River has been secured as a location for the permanent laboratories.

The officials and the faculty members of the Institutum Divi Thomae are grateful for the blessings which God has bestowed upon the institution since its founding, and it is their prayer that the future will be equally successful. It is their fond hope that this work will prove to skeptic and believer alike that religion and science are not in conflict; that religion and science can and do proceed harmoniously. They are strengthened in this hope by the words of His Holiness, Pope Pius XI, who has said "the Church blesses and fosters every healthy initiative and has no fear of progress, even the most daring progress, of science, if only it be true science."

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The Cost Of Equipping

Continued from Page Fifty-two

Quantity	*Apparatus*	*Cost*
1 doz.	Blow pipes,	1.20
1 doz.	Triangular files, 4",	0.84
2 doz.	Pipe stem triangles,	1.20
2 doz.	Wire gauzes with asbestos circles,	1.44
2 doz.	Burette clamps,	6.00
2 doz.	Iron rings, 2" diameter,	3.36
2 doz.	Small ring stands,	10.80
3 only	Erlenmeyer flasks, 300cc.,	0.60
3 only	Erlenmeyer flasks, 500cc.,	0.75
4 only	50cc. Burettes,	2.00
3 only	Bunsen burners, (Tirrill type),	2.92
6 only	Cobalt glasses, 2"x2",	0.24
1 only	Mortar and pestle, 60cc.,	0.35
2 only	Large ring stands, No. 3,	1.20
4 only	4" iron rings,	0.72
2 only	Funnels, 45mm.,	0.32
1 only	Harvard trip scale,	7.15
1 set	Weights, 10mg. to 50g.,	2.90
10 only	Wooden blocks for reagents and test tubes,***	17.50
4 only	Tripod magnifier,	3.00
4 only	Horseshoe magnets,	0.80
18 only	Test tube brushes,	1.14
	Total Apparatus Cost - -	$178.49

CHEMICALS

Practically all of the chemicals are such as are used in any course. They were purchased in one-quarter pound lots. These will do for a period of several years with classes of average size. The total cost was $46.68.

Total Cost of Chemicals -	$ 46.68
Total Cost of Apparatus -	$178.49
TOTAL - - - - - -	$225.17

From the foregoing, it will be seen that the initial cost is very low. Also, it must not be forgotten that the chemicals purchased will last much longer, and that replacements of these and of glassware can be made at a very reasonable cost. For those schools which already have a laboratory, the only expenses to consider would be those listed above. We have not thought it necessary to give an expense account involving the purchasing of desks and chairs, and the making of gas connections. Many of these things are already available at most schools, and the building engineer, or some "handy" man, can take care of the preliminaries.

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? ? ?

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Air Conditioning

Continued from Page Forty-nine

in the air conditioning of the home, there are at present, a number of cabinet types which are designed to care solely for the room in which they are installed.

Although air conditioning in the home is now very much improved, it is nevertheless a difficult and complicated process. The true purpose of air conditioning should be thoroughly understood and the desired conditions well known before any attempt is made to install it, and only experienced engineers should be employed in its installation.

Although existing houses can be equipped with this new comfort of air conditioning almost as readily as new houses, it is nevertheless wiser and more economic to make installations while a house is being built.

The air conditioning system is certainly a "new deal" for home comfort and there can be no doubt but that it is here to stay.

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Good Housekeeping, February, 1936, pp. 89, 135.
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Negative Hydrogen Ions

Physicists and chemists have long been familiar with the properties of the positive hydrogen ion, but a "negative hydrogen ion" is something new.

In the January 1 (1936) issue of the Physical Review, Dr. W. H. Bennett and his assistant, Paul F. Darby, of Ohio State University, report that they have established the existence of negative hydrogen ions. They have observed these ions directly in heads of striations in discharges through water vapor. These H^- ions were formerly supposed to exist in discharges in gases in order to explain some of the phenomena exhibited; but they had not been observed directly until recently. In the experiments at Ohio State University the H^- ions were detected as such by passing them through an electric lens system similar to the apparatus used in mass spectroscopy.

It is predicted that the new ion may be a useful particle in bombarding atomic nuclei, since the positive nuclei will attract the negative ions, increasing the effect of impact.

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New Laboratory Method

Continued from Page Thirty-eight

and distinct. This is a very great advantage when several students are working the experiment in the same room.

No. 10. STEAM JACKET

This illustration shows the same tube used as a steam jacket for the experiment to measure the volume of a gas at different temperatures. The expansion tube is kept in a horizontal position and readings are taken at room and at boiling temperatures. Glass tubes for steam jackets and resonating tubes are too often broken.

No. 11. LINEAR EXPANSION APPARATUS

The coefficient of linear expansion of a metal tube, 30" long, $\frac{5}{16}$" bore, is determined. The clamp and support rod give to one end of the tube a very rigid support. Near the other end of the tube is a groove which rests on the sharp edge or end of the short arm of the lever. The movement upward of the end of the lever and the expansion of the tube have the same ratio as the arms of the lever, which are made ten to one.

No. 12. A WHEATSTONE BRIDGE

The bridge shown is home-made with three triple-connection binding posts, a half-meter stick and a bridge contact key. Number 30 German silver wire is used for the bridge wire. It is built on a base board 21½"x8½". All dividing circuits at a point being made on one binding post, no solder is used and no varying contacts are possible. The small screws on the top of the board are so placed that a student may put wires of different lengths (3 and 2 feet) and different diameters in the unknown resistance gap. The two lengths may be connected at the same time for determining the resistance of a divided circuit.

OTHER APPARATUS

The following three pieces have been simplified and thus greatly reduced in price. They are ordinarly expensive items. Several are needed in a well equipped laboratory.

1. A resistance box with eight coils instead of twelve. A total of eleven ohms is all that is used in high school physics. An extra binding post is placed at one end between the 3 and 4 ohm coils so that one box may serve as two for parallel circuits.

2. A smaller block of weights, containing weights from 10 to 200 grams or a total of 600 grams. For the trip scale with its 10 gram rider-beam these are all the weights needed.

3. A boiler to take the place of apparatus "A" without a water level gauge and a side delivery tube. The top is constructed to receive a two-inch stopper. With two stoppers (one hole and three holes) all

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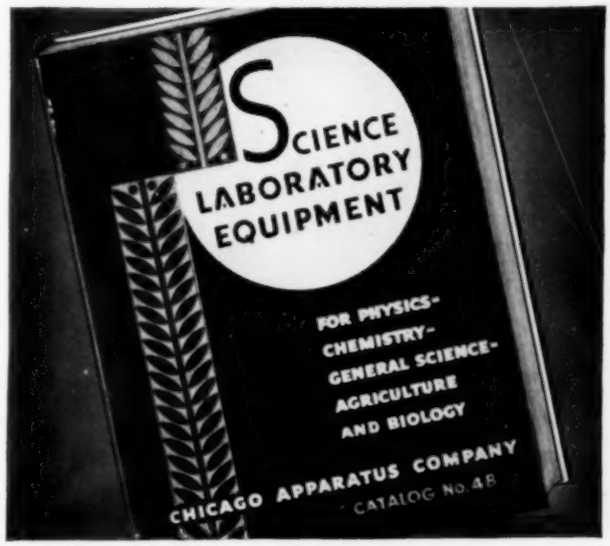

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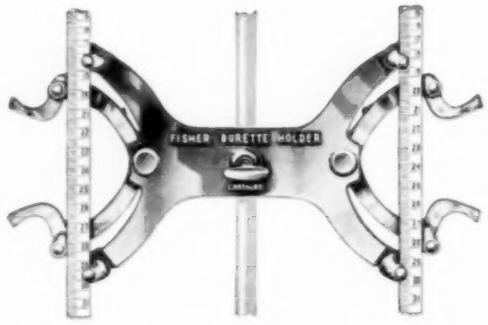
Is Energy Conserved?

Prof. Dirac, of Cambridge University, believes that the law of conservation of energy does not hold in processes involving very high speeds, comparable to the velocity of light, and probably not in processes involving radiation. Energy and momentum are conserved, however, in atomic and other processes when the velocity is small compared to that of light. Prof. Dirac bases his conclusions on the new experimental work of Dr. Shankland of the University of Chicago. Dr. Shankland's experiments involve the scattering of gamma rays by matter.

◆

Nature's System of Checks and Balances

Good news comes from the Branch of Forestry of the National Park Service, based on recent reports received from national parks and monuments in the West, where an unusually severe winter was experienced. This unprecedented cold was one of Dame Nature's balancing devices. Insect infestation of the trees in these regions will undoubtedly be lessened next summer because of the winter kill of encysted insect larvae. In the vicinity of Lassen Volcanic National Park scientists of the Bureau of Entomology and Plant Quarantine estimate that the western pine beetle suffered a mortality of from 15 to 80 per cent during the sub-zero January weather.



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Geology And Its Relation

Continued from Page Forty-one

economic resources. Ores, formed deep in the bowels of the earth, are folded up into mountain ridges. The erosive power of streams gradually wear them to the surface. Then they become available to man. Even a desert, like that of Death Valley, California, which caused the death of many of the gold-crazed "forty-niners," is not without economic importance because it provides us with the famous "20 Mule Team" borax. The "Lost Mountains of Wisconsin" antedated the Appalachians by a greater amount of time than the Appalachians did the Rockies. That they were peneplaned some two hundred millions of years before the advent of man, is scientifically demonstrable. In spite of this, they have left behind "scar-tissue" that would not be there had they never existed, and the uplands etched from their ancient bases contrast strangely with the abutting and relatively unfolded sedimentaries about them. In these scarred remnants of what was once a mighty alpine chain are found the lodes of valuable economic minerals. Did you ever consider that the mineral wealth of nations lies in the remnants of topography that *was;* that the great reservoirs of coal and oil which form the veritable pulse-beat of modern industry represent myriads of organisms that lived, died, and were buried in the dim recesses of the past?

In order to interpret conditions as they exist, the geologist must have a knowledge of the other sciences. Microscopic bacteria are agents in the breaking down of rocks into soil in which plants may thrive. Algae, diatoms, and foraminifera aid in the building up of great deposits of travertine, diatomaceous earth, and chalk. The distribution of plants and animals is governed by climatic conditions, which in turn depend on geological phenomena. The locations of cities are influenced by soil, streams, natural harbors, mountain ranges, mineral deposits, or other deposits of economic importance, all of which are the result of geologic phenomena.

Too often students of science lose sight of the fact that the various sciences as taught are not separate entities, but merely different methods of approach to the study of the fundamental laws of Nature. The man-made boundaries of science are as artificial and flimsy as the political boundary lines that delimit nations. However, they fulfill the important duty of acting as a basis of classification for the myriad of facts that confront the modern scientific investigator. For instance, let us briefly compare the reaction of a chemist, a physicist, a biologist, and a geologist, as to what the atmosphere is. To the chemist, the world is made up of little particles called molecules which are the chemical building blocks of which elements and compounds are formed. These molecules are made up of still smaller units called atoms. The two principal components

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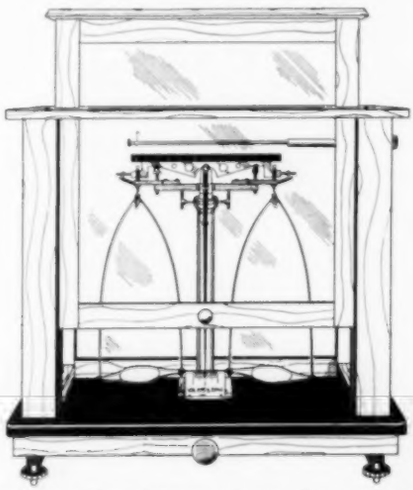

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of the atmosphere are the elements nitrogen and oxygen. Oxygen is the active partner of this pair combining with other elements and compounds, thereby oxidizing them. The physicist would not be so concerned with the composition of air as with its obedience to the laws of gases. When physicists talk about molecules, they emphasize their relationship to the transfer of energy. On the other hand, a biologist, speaking of the same atmosphere, would stress its importance to animal life and the function of breathing. To the geologist, the atmosphere is mainly a medium that causes rock disintegration and ultimately changes the surface features of the earth. Each looks at the same concept with a different idea in mind, yet all must borrow copiously of the other's wares if they would successfully solve their own problems.

By this brief review I have sought to conjure before you the enormity of space and time, and to show how each branch of science is but another viewpoint from which to contemplate the universality of natural laws. We call the various procedures by which we study them, biology, physics, chemistry, geology and geography, but they are all parts of the grand universal scheme of things, segregated and classified under one viewpoint. I have naturally leaned toward geology because it is my chosen field, but all sciences are, to use the famous motto, "One for all, and all for one," and each has its value to humanity. Whether of the Arts or Science type of mind, we cannot help being social beings, and one of the first steps of the sociological ladder is to understand one's environment. Go out and study Nature! It will broaden your conversational powers; it will make your automobile tours more interesting. Natural phenomena will seem still more intriguing if you know how they evolved, and why. The field of geology tells us these things more readily than any other natural science, because it is the clearing house for all others. No matter what your ultimate goal in life, a little geology will season your scientific specialty and provide cultural background as well.

"Nature ever yields reward
To him who seeks and loves her best."

Barry Cornwall.

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Slow Neutrons

Streams of neutrons travelling at low velocities are more effective in disrupting atomic nuclei and causing transmutation of elements than neutrons travelling at high speeds. At least, this is the conclusion reached from recent experiments on slow neutrons. The high speed neutrons apparently pass through some substances without appreciable effects, while the slower particles are captured by atomic nuclei, causing the atoms to "explode" and change their structure.

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